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THE EFFICIENCY OF ENGINEERING PERSONNEL IN THE NAVY.

By Walter M. McFarland.

The grave danger to the efficiency of the Navy which lies in the false place accorded the engineer has, we fear, increased rather than diminished within the last few years. It is insidious because it works wholly out of sight, for the most part, of that influential public opinion which would enforce a change if the conditions were thoroughly and widely understood.

The Bennington disaster is a sudden and shocking revelation of how far things have gone, in the United States Navy, on the road which leads to impotence as a sea power. The accident, probably unparalleled in the merchant marine, can be traced directly to conditions which would never be tolerated in the merchant marine. If such dangers spring from the Navy policy toward the engine room in the ordinary routine of peace, what might be expected in the stress and emergency of war?

We are glad to offer, in the following two articles, the authoritative views of men amply able to speak for the navies of the United States and of Great Britain. The remedy can come only by a process of education, changing gradually the traditional attitude toward the engineer on shipboard. But we believe, with Mr. McFarland, that when the "men at the top" accept and entertain ideals which put engine-room service at least equal with deck service in point of honor, dignity, and recognized achievement, all tendency to discriminate between the two branches will disappear.—THE EDITORS.

THE condition of the engineering personnel presents at this time one of the most difficult problems which confront the authorities of the navies of the world. Although several different schemes of administration are being tried, none gives complete satisfaction. The following article shows that this is the case in Britain. The reports of the Engineer-in-Chief and the proposed schemes of the

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Secretary of the Navy prove it for the United States. In other countries, the engineers themselves have been dissatisfied and discontented for years because they have not been accorded the rank and position to which they are entitled. What is the reason?

A careful study of the situation suggests that the trouble is due to the coming of an inevitable change in one of the most conservative of organizations—the Navy; and to the opposition or inertia of those who have been trained for years under the old order. Steam was at first barely tolerated, and the men who guided its use had no rank at all. It was even accounted a concession in those early days of "the cat" that they were not to be flogged. In the American Civil War, engineering played a great part under the talented Isherwood; but not long after its close, Admiral Porter would have stopped its progress by removing all the fixed propellers and substituting hoisting screws, so that sails would be the usual motive power, with the engines for use only in emergency. He was a sailor, pure and simple. As late as 1885, he went on record as opposing for the new United States Navy the arrangement of sails as an auxiliary to steam, saying that it should be just the other way, with steam as auxiliary to sail power. Of course this was an anachronism, but it was only an extreme manifestation of the feeling shared by a large part of the sailor element. There were, it is pleasant to record, highly progressive officers, like Commodore Foxhall Parker, who advocated mastless ships twenty years before they came.

As the wheels of progress turned, machinery came to play a more and more important part in the economy of the war vessel, affecting not only the motive power, but the guns, the steering gear, torpedoes, etc. Although the sailor officers were largely indifferent to machinery when used for propulsion only, they took hold of it for the matters that were under their own purview until, towards the end of the last decade, a really efficient deck officer had to be a pretty good engineer, and some openly asserted that they were engineers.

This was the condition of affairs in the United States Navy when Mr. Roosevelt became Assistant Secretary in 1897. There had been going on all these years a long and acrimonious strife, mainly between the engineers and the deck officers, owing to the demands of the former for position and rank adequate to their duties and responsibilities. To the protagonist of the "strenuous life," who had just come from the daily combat of the Board of Police Commissioners in New York, the naval strife was a tame affair; but he loves efficiency, and with his keen insight, soon discovered that efficiency was being sacrificed to bickering and jealousy. Suggestions for improvement had been made by many true friends of the Navy, and these led Mr. Roosevelt to take active steps toward a solution of the difficulty. The method proposed eventually took form as the "Personnel Act" of March 3, 1899, under which the Navy is now working. Its essential and basic feature is the amalgamation of the engineers and deck officers, with the avowed purpose of making every executive officer an engineer as well as a seaman.

I was a member of the Board which framed the bill and took an active part, by Mr. Roosevelt's selection, in its presentation to Congress and in the public press. I still believe in the correctness of the principles of the bill, and concur heartily with the repeated statement of my old chief, Admiral Melville—"If the scheme of the Personnel Bill is administered with an honest desire to make it a success, it will produce high efficiency." The obvious inference was that if administered without such a desire, we would have inefficiency. From all that can be learned by diligent inquiry, this is exactly what has happened.

It was pointed out by many persons, including members of the Naval Committee, that the Personnel Bill was weak in not giving detailed instruction about the education in engineering and the performance of engineering duty. I replied that these were really matters of regulation by the Navy Department and did not belong in the bill. I could not then believe that the Department would fail to carry out the plain intent of Congress, and would neglect such a vital element of naval efficiency as engineering. Events have proved that I was too trustful—not to say entirely wrong.

When an almost identical plan was adopted for the British Navy, more care was taken on this point, and it seemed as though the "new model" would here prove its efficiency. It would appear from the following article that this view is also too sanguine. At all events, the kind of modification which it is receiving cannot fail to ruin it. The idea of putting firemen in responsible charge of the watches under steam seems impossible to one who has ever stood a steaming watch on a modern war vessel. Things had not gone to quite so low a plane as this on the Bennington, but the disaster there was due simply and entirely to the utter neglect of proper engineering training and administration. The axiom that like causes produce like effects is not suspended in the case of naval engineering, and if the same neglect is allowed to obtain on other vessels, we must expect similar disasters.

Soon after the Personnel Board had made its report, I published, with the sanction of the Navy Department, an article explaining the scheme and defending it against the anticipated charge that it opposed specialization (which has frequently been made), and also the intimation that the propelling machinery would be neglected. I said substantially that, in my judgment, the motive machinery *ought* to receive better care because, under the new plan, where every officer was to be an engineer, the captain would have the same professional interest in the motive power as in the guns, and it would be "my engines" and "my mechanics" instead of "yours." Any mishap to the motive machinery would be a reflection on the whole corps of executives and not on a special body of engineers. In theory, this is as true now as when it was written in 1897, but it has not worked out in practice.

The reasons for the failure to carry out the provisions of the Personnel Law seem to be closely akin to those which for so long a time hampered the advance of scientific and technical education. Almost the whole of the staff of instructors in the colleges had been trained in the old classical method. They considered the other courses distinctly inferior to their own carefully embalmed learning. A grudging consent to the pursuit of these courses in the same institution was nevertheless joined with insistence upon a different degree, which they proclaimed to be of a lower order than the standard A.B. Time has gradually removed these intense conservatives and now, in the more progressive universities, the classicists are off in a small corner.

The tone of the naval personnel depends almost entirely on the higher officers, those of command and flag rank. The ideals which they hold up to the younger officers are the ones that are eagerly followed. In the decade following the Civil War, when Admiral Porter was supreme, this ideal was the bold sailor who carried canvas till it blew away. As Commodore Foxhall Parker said, a little later, "Not to talk rope was not to be a seaman, in the opinion of most officers." As a result the midshipmen "talked and thought rope" continually, and exerted every effort to become fine seamen. Can there be any doubt that the same encouragement of engineering, which is now the vital element, would produce equally good results in arousing an enthusiasm to become competent engineers? Unfortunately, the actual conditions are very far from such an ideal. One would expect that, if no officer with actual engineering training is available, the one detailed would at least be a man of considerable experience and chosen from near the top of the list of those on board. In many cases, the exact reverse is true, and the nominal chief engineer is one of the juniors with scarcely any experience of any kind. The unfortunate lad who was in charge of the Bennington's machinery was next to the lowest commissioned officer.

The following article very truly states that, when choice is given between the normally easy and pleasant duty on deck and the much harder and less agreeable duty in the engine room, very few will fail to select deck duty. The obvious moral to be drawn is that which many of us clearly saw when the scheme was started—namely, that all watch officers must alternate at very short intervals between the deck and the engine room, so as to be thoroughly at home in either place.

It has been demonstrated repeatedly that officers will perform cheerfully the most disagreeable duty, when it is a regular part of their functions, and this simply confirms what has been said before—that the whole solution of the problem rests with the officers of high rank. If they encourage engineering and make engine-room duty as regular and frequent as deck duty, the conditions planned by the Personnel Law will be carried out and we shall have high efficiency.

In spite of such occasional anachronisms as the building of sailing ships for the training of officers who are to serve in mastless steamers, the great fact remains which was so thoroughly grasped and stated by Mr. Roosevelt, namely, that the thoroughly efficient officer on a modern war vessel *must* be an engineer, whether he wants to or not. The efficient care of the motive machinery is just as much a part of his duties as the care of the guns, turrets, or torpedoes. Unless the integrity of this great department is assured, no amount of skill with the guns will prevent disaster in the day of battle. It has already come, on the Bennington, under the usual conditions of every-day routine. What, then, could be expected during the excitement of combat?

A careful study of history should teach us patience. No great forward movement ever went in an absolutely straight line. Because in recent years the British Navy has been highly efficient, and because it is justly proud of Drake, Frobisher, Nelson, Collingwood, and others, we are apt to think it was always efficient. History tells us, however, of "gentlemen captains" who knew nothing of ships, but a great deal of the etiquette of courts; and of officers who were really seamen but were left without pay. Within a hundred years after the defeat of the Spanish Armada, the British Navy had become the despair of its friends and the contempt of its enemies. The period of evolution was very long before the Navy was regularly organized on the efficient basis of combining, in the same man, the resourceful executive and the skilled manipulator of the motive power. The same problem, with the kind of motive power changed, confronts us now. There is no excuse for long delay in adjusting ourselves to the changed conditions, and the only explanation is the conservatism and inertia of human nature. Progress is vastly more rapid now than it was three-hundred years ago, and our naval men should not move at a slower rate than the great executives of business and industry in making the organization fit the work to be done.

To hold that the scheme of the Personnel Law was perfect in all its details would be claiming a great deal, but a careful study of the history of navies and of present needs makes it seem almost certain that the plan finally adopted must be along its general lines. In ancient times the soldier element was supreme, because the real fighting was done when movement of the vessels had ceased and they became merely the field on which a hand-to-hand conflict was waged. In the modern sea fight everything depends vitally on machinery—the movement and direction of the vessel, the loading and pointing of the guns, the manipulation of the torpedoes. Under these conditions, victory will assuredly rest with that fleet whose officers are professionally competent to control and use the tremendous energy of the machinery for which they are responsible; and they only are thus competent, whatever their actual titles, whose training and experience have made them skilful engineers.

BRITISH ADMIRALTY POLICY AND ITS CONSEQUENCES.

A Naval Contributor.

MANY people were intensely sanguine, when Lord Selborne's famous "Memorandum" startled the world on the morning of Christmas Day, 1902, that at last the burning question of the rank, titles, and executive authority of naval engineer officers had been permanently solved; and that henceforth there would be peace between the two real executive branches of the Navy. When the First Lord of the Admiralty had advanced sufficiently along the road of scientific progress to be able to pen the words which follow, the naval engineer as well as the ordinary civilian might well be excused for falling into the very pardonable error of believing that the written document conveyed the real meaning of the First Lord's projected new policy. The words referred to appear in the third paragraph of Lord Selborne's "Introduction," and read thus:—

> "The application of steam to ships of war as a source of motive power was the first sign that the old order was beginning to change. At first admitted grudgingly as an occasional auxiliary to the sails, then acknowledged as an equal partner, then winning for itself *supremacy*, today the steam engine has no rival, and sails have forever disappeared from the equipment of fighting ships."

Well might those who for so many years had watched with mistrust and anxiety the heartbreaking nepotism of the sailor element at the Admiralty and throughout the service generally—well might they flatter themselves that the dawn of a brighter era had burst upon the Navy and the naval engineer; that at last the great science which—even under the most strenuous opposition—had succeeded in proving its right to be considered, if not the first, at any rate the second great factor in naval warfare, was to have its rightful place; that now we were to see steam and the engineer taking their proper position in the naval service, and becoming, as it had always been contended by progressive and unprejudiced minds they should become—the colleagues and equals of the sailor element. There was one dominant, irrefutable truth standing out clear as the beam of light from the electric search-lamp, and throwing its penetrating rays over the wide expanse of the Navy and the empire it was created to defend—and that truth was, that a new candidate had arisen to dispute the predominance, the supremacy, of the sailor's art, and to claim rights as his co-equal and coadjutor in all things naval.

The rôle of Nelson's successors had become that of the steersman and navigator, and the man behind the gun. The propulsion and manœuvring of the ship had passed into the hands of the mechanic down below. As time went on, more and more of the functions of the warship devolved on him, until he had become so pre-eminently the arbiter of its fortunes that even his most determined opponents came to realize that either they must take up engineering, or be content to play second fiddle in the naval orchestra. So thoroughly did the sailormen, at the Admiralty and in the ward-room, realize that the command was passing from their hands into those of the "man below," that they were naturally aroused from the slumber of security into which their long and hitherto undisputed reign had plunged them. Recognising the indisputable claims of their successful rivals, they suddenly awakened to the fact that they must either take to engineering themselves, or be content to see themselves relegated to the second position in the rule and government of the Navy. That things had come to this pass they acknowledged only among themselves, in the privacy of confidential whispers. Towards the world and their rivals, they maintained the aggressive superiority with which years of dominance had apparently invested them.

As the anomaly of their position became daily more evident and conspicuous, a very real attempt was made by the Board—at the instigation of the gunnery officers at first, and afterwards followed up by the torpedo men, as they were made, or created—to usurp some of the functions pertaining to the engineer, with the hope of finally relegating him to his engines and boilers. When it was found that this policy was ineffective, they began to cast about for another, which, while soothing the "struggling lion," should permit them to retain at least a semblance of supreme power. Their desire was to have the command, to be engineers in name, though not in fact, and still to preserve unsullied the exquisite whiteness of their immaculate hands; if by any means they could become engineers without incurrring that last and crowning indignity, the workingman's hand. Some of them even went so far as to throw a sop to Cerberus by actually erecting a toy lathe in their cabins, under the delusion that when they could turn a bit of iron or gun-metal into some definite form they might arrogate to themselves the title of engineer. And their superiors—who chafed uneasily under the consciousness that a power which they could not control was rising to take command of the Navy—encouraged them in the delusion; belittled the naval engineer as far as it lay in their power to do, and sought by every means at their command to stay the coming of the new king. Needless to say, these efforts were vain. Science, with irresistible advance, which no power on earth could arrest, gained upon them day by day, until eventually they found themselves with their backs to the wall, and nothing left for them to do but to surrender at discretion. Sir John Fisher, one of the ablest of the gunnery men, was really the inventor of the New Scheme, though it bears the *imprimatur* of the late First Lord of the Admiralty —Lord Selborne.

The Scheme is decidedly clever! It aims at nothing less than "getting the lion inside the lamb," and it is proposed to accomplish this end, by the usual method of fascination of the victim. The Lords Commissioners of the Admiralty appear to have supposed that the engineers would be taken in by such trifles as "titles" without the attributes which have hitherto accompanied them. They appear to have thought that the mere fact of calling them officers of the executive branch, whilst withholding from them the exercise of executive authority, would be sufficient to blind the engineers to the deception which was being practiced. One could use some very strong language in dealing with this matter, but it is needless; the shame of the thing will come home to its instigators and concoctors. Did they for one moment believe that such a sentence as is quoted below would satisfy the aspirations of the naval engineer? Legitimate aspirations, be it observed, for one of their own class, an admiral, had said years before, that in his opinion "an engineer officer should have the power to give an order to any man in the ship, without any possibility of that order being disobeyed or even questioned"; and this is what they offered:—

> "The pay of the existing engineer officers will be raised, but no changes will be made in their uniform or in the regulations which define their duties or in the provisions of the Naval Discipline Act."

If any of the executive officers who assisted in the drawing-up of the New Scheme "laid the flattering unction to their souls" that the engineers would be content with such a fraudulent prospectus as that, they must be even greater dupes of their own imaginings, than they considered the men would be to whom they paid so poor a compliment. Executive command, and control of the men in their own department, has been the foremost demand of the naval engineer. Whether he be given executive rank, title, and authority by the provisions of a new Naval Discipline Act or not, he still has to exercise control and to command his men, as best he can, for there is no other by whom it can be done; and this being so, the engineers have endeavoured to show to the Admiralty how much easier such duties could be accomplished, if military command were devolved upon them, with the outward symbols marking executive rank, and the powers which accompany executive rank in the sailor branch. The contention of the executive officers has been that the engineer is not trained to command! This contention is especially emphasized in paragraphs 9, 10, and 11 of the "Introduction" to Lord Selborne's Memorandum, from which the following sentences are selected, the italics being my own:—

> "In dealing with this question (i. e. the question of 'a more general scientific training') the Board have been always conscious of the supreme importance of preserving to the Naval Officer *his unmistakable naval character*" (par. 9).
>
> "This character is developed from the *early training in responsibility*, the *powers of self-reliance thereby engendered,* and the essential unity of the Service." "It is true that no student will ever become a victorious leader unless he is also a practical seaman and *has the power of influencing men*" (par. 10).

> "The strength which its unity gives to the Service can hardly be over-estimated, yet in respect of this very matter a strangely anomalous condition of affairs exists. The Executive, the Engineer, and the Marine Officers are all necessary for the efficiency of the Fleet, they all have to serve side-by-side throughout their career; their unity of sentiment is essential to the welfare of the Navy; yet they all enter the Service under different regulations, and they have nothing in common in their early training. The result is . . . that *the Engineering Officer has never had any training in Executive duties*" (par. 11).

Obscure as portions of these sentences are, one unmistakable meaning pervades them all—that the training of the engineer officer does not fit him for command of men! The absurdity of such a contention is obvious. He *has* to command men; and he and his predecessors have commanded men ever since steam was introduced into the Navy. That his command would have been more effectual, of higher value to the Service, if he had been from the first invested with full executive rank, uniform, and authority, it is not now necesssary to insist—we have Lord Selborne's own words to show that it was this one thing which the engineer officer lacked. That he has struggled so long against the stream, and with such marked success, only emphasizes the greater success which would have been attained had he possessed the powers for which he asked.

The attitude of the Admiralty on this subject would seem to indicate that there exists a racial difference between the men who form the executive, and those who fill the ranks of the engineering branch of the Navy. It is the old fetish of the days of feudalism, which has never yet been extirpated from the naval and military services of Great Britain. The substitution of a system of common "Supply," "Entry" and "Training" show that the Admiralty still indulge in the mistaken notion that naval officers of the three executive branches of the Service cannot possibly fill their respective positions, unless they originally come from one source. No theory was ever evolved from more unsubstantial premises. What has been the history of the engineering department of the British Navy since its inception? Has it not been in a marked degree successful, progressive, anticipatory? Has it, as a whole, ever been found wanting in initiative, in resourcefulness, in courage, in resoluteness, in all the attributes which go to make leaders of men?

I venture to assert without fear of contradiction—even from the most influential member of the opposite side—that if the records at the Admiralty were searched, those of the engineering branch would be found well able to hold their own with any other branch, and especially so with the executive branch. Look at the number of inventions, now in use in the Navy, the greater part of which have come from the engineering branch. Who was it who introduced the water-tube boiler into the Navy, when the superintending engineers of the great mercantile navy stood aloof and would none of them introduce them into their ships—aye, and many of them even now refuse to do so? And yet where would the British Navy be today but for its water-tube boilers? It required an immense amount of courage, and those other attributes enumerated above, to enable the Engineer-in-Chief to go forward against the torrent of adverse criticism which followed his bold administrative action; and many a stronger man might have collapsed under the weight of the bitter professional opposition he had to endure. But is there any question today as to the soundness of his decision? Is it not the fact that in every squadron those ships which the Commander-in-Chief can most certainly rely on at all times and in all circumstances, are those with the water-tube boiler?

Hitherto this paper has dealt only with the New Scheme as propounded in Lord Selborne's notable Memorandum of Christmas Day, 1902. Recently there has been published a "Blue Book" (Cd. 2791) containing "A Statement of Admiralty Policy." On carefully reading through its pages one finds that a change has come over the Scheme. As it emanated from Lord Selborne, it was stated distinctly that after attaining a certain rank in the Navy, the officers entered under its provisions would separate into the three branches of the Service for which they were especially fitted—the executive, the engineering, and the marine. The following is the text of Lord Selborne's note on the subject:—

> "When the young officers, aged 19 to 20, have passed out of the College at Portsmouth as sub-lieutenants, and have gained their classification in the different subjects of the examination, their careers for the first time will begin to diverge, and they will be posted to the executive or to the engineer branch of the Navy or to the Royal marine. As far as possible each officer will be allowed to choose which branch he will join, but this must be subject to the proviso that all branches are satisfactorily filled. No sub-lieutenant will be compelled to join a branch for which he did not enter as a boy when applying for a nomination, but in giving nominations for competition for entrance to the 'Britannia' preference will (other things being equal) be given to those boys whose parents or guardians declare for them that they will be ready to enter either of the three branches of the Service. The Board of Admiralty will thus have in reserve a means of remedying a surplus or deficiency in either of the three branches, and of ensuring that every branch receives a due proportion of the most capable officers."

The Admiralty foresaw, as they most assuredly had a right to anticipate, that that branch of the Service in which are to be obtained the most honor and glory, combined with the power of command, and all the exclusive privileges which follow in the train of the paramount position, was that for which a preponderating inclination would be shown; and in making the stipulation that preference would be given to those boys willing to take either of the three branches, the Admiralty thought they had got over the chief difficulty likely to beset their Scheme. That these pious expectations have not been fulfilled is tolerably well-known in the Navy. It appears to be pretty clearly established as a fact that the voluntary engineering classes have not been attended as fully as the Admiralty desired they should be; and that the voluntary examination papers on engineering subjects have been subjected to "exclusive treatment." In other words, they have been "left severely alone." Of course, if the cadets decided to give engineering a wide berth lest they should be relegated to the "regions below," when they were all anxious to aspire to the quarter-deck and the fore-bridge, the Admiralty design began to lose some of its most hopeful results. There would be no engineers for the Navy! In this dilemma the L. C. A. cast about for a way out of the difficulty. The new First Lord (Lord Cawdor) was prompted (by the Sea-Lords no doubt) to institute a committee

> "to consider whether the time has arrived to formulate regulations for the allocation of the duties of future officers in the various branches of the Service, and to report:—
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> "(a) Whether any necessity exists for the distinct classification of such officers under existing branches of the Navy, with a view to their remaining specialized for the whole of their future service.
>
> "(b) Whether specialization for a period of their career only is necessary; and if so, to indicate the procedure that should be followed to carry out the necessary duties of the Service afloat.
>
> "(c) How best to provide for filling efficiently the higher scientific appointments of the Admiralty and dockyards."

The New Scheme has been in force only a little more than two and a half years, yet the L. C. A. announce that "The progress of the cadets during their first two years has been most carefully watched and at the close of this period the Board felt that the experience gained warranted them in instituting a detailed enquiry into the probable future development of the new officer." In passing, it may be noted, that the constitution of the committee is not stated. So far as I have been able to ascertain, no engineer officer was on the committee. If this was the case, one naturally asks "Why?" Why was not that branch of the Service represented which is most interested in the questions submitted for consideration? But what experience could possibly have been gained in so short a time as to render it not only possible, but actually necesssary, to review the provisions of the Scheme of 1902? The indecent haste thus exhibited to tamper with a policy not old enough to have given any reliable indications as to its probable results would seem to confirm the rumours which are afloat in the Service that the New Scheme would not work on existing lines. Parents and guardians, who had promised on behalf of their children or their wards that they would be willing to enter whichever branch of the Naval service they might be selected for, began to dread the possibility of their protégés becoming engineers. They all gave the promise with a sort of mental reservation, that their own particular cadet was not to be selected for any other branch than that for which they designed him—the executive! This is admitted in the report of the committee, though not in such direct terms as it is stated here. The following quotation from page 13, line 18, is the clue to the reason underlying the appointment of the committee in such haste.

> "Uncertainty as to future developments has in some cases exercised a disturbing effect, not only on the cadets but also on their parents and those interested in them."

There we have the whole case in a nutshell. And so we find the committee reporting (page 13, line 20):—

> "Now that sufficient experience of the working of the New System has been obtained, it is desirable that definite regulations for future procedure with regard to the allocation of officers to the various branches of the Service should be formulated and promulgated at the earliest possible moment. This question has received earnest consideration, and, so far as concerns those entered under the New System, it has been decided that all executive, engineering, and marine duties will be performed by executive officers of common entry and training, who will specialize for the different duties without separating into permanent and distinct branches. The consequence of this development of the original proposals is that there will be in future only one class of officer in all departments, and, whether performing engine-room, marine, gunnery, torpedo, or navigating duties, all will be equal, all will be executive officers."

The "bogey" of the engine-room and the stokehold has frightened both the cadets and their friends, and there is little doubt that the Admiralty has been informed by the officials at Osborne that the possibility of being ultimately appointed engineers has caused engineering studies to be evaded, in order that the particular cadet should not be found better acquainted with engineering subjects than his fellows. The wonder is that the Admiralty should ever have supposed that their scheme would work, in the form in which it was presented in 1902. I do not think any engineer thought that it would. As long as the mode of entry is the same, and the rates of pay the same, and the rate of progression in rank is the same in the executive, the engineering, and the marine branches, naturally enough each cadet will select the executive if any choice be allowed in the matter. The change which the committee has recommended the Admiralty to adopt and which the Admiralty has adopted, will not mend matters a bit. They must face the fact, disagreeable though it be, that inducements must be offered to the cadets to take up engineering, or the engineering department of the Navy will be starved of efficient and capable officers. Is it likely that a young officer is going to take the work "below" if he can by any means get on to the "bridge"? It is absolutely certain that he will not so long as the rank, pay and emoluments are the same. If, therefore, it is desired that the cadets should be willing to enter the engineering line, and remain in it—for it is impossible that the project of eternally moving officers out of a "square hole" into a "round one," and *vice versa,* can ever be made to work—incentives must be placed before them which will induce them to choose the less agreeable vocation.

The Scheme of 1902 convulsed the Service from top to bottom, and the new policy as declared in the "Blue Book" published three years later will not tend to steady its pulse. As far as the engineering department is concerned, this continual change of policy keeps it in a state of effervescence. Neither officers nor men know where they are. The constant changes and suggestions of change keep the whole body in a condition of ferment, and as a consequence this department of the naval service is in a state of unstable equilibrium—a condition which it must be apparent to all who think at all on the matter cannot be conducive to the best interests of the Navy. This instability is increased by rumours which arise from time to time of "confidential letters" to the Commanders-in-Chief of the various stations and squadrons, with reference to the engineering question. At the present time it is currently reported that such a letter is going the rounds of the Flag officers on active service, in which it is suggested, or stated, that no officer of the rank of commander is needed in the engineering department. There would seem to be some foundation for this rumour, when one grasps the real policy of the Blue Book under discussion. For instance, on p. 17, under sub-head (2) in which "The Duties of Engine-room Watchkeeper," are dealt with, it is stated that:—

> "The Admiralty have devoted considerable labour to the subject of the provision of a suitable class of man to help the junior engineer

> officers in engine-room watchkeeping. At present this work is done by engine-room artificers, whose chief attainment is that of a skilled specialized mechanic. While in the Navy he is trained and taught engine-room watchkeeping, which results in considerable loss to the Service of mechanical and repairing talent when the ship is under way."

In order to put an end to this loss of their mechanical and repairing talent—which is purely suppositious—the Blue Book goes on to say, on p. 18, that:—

> "The engine-room and stokehold watchkeeping can be performed by men specially selected from the stoker ratings of the Fleet, and suitably trained.
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> "As soon as sufficient stoker ratings are qualified for engine-room and stokehold watchkeeping, engine-room artificers will be released from these duties to do the maintenance and repair work which will, in future, be chiefly what is required of them."
>
> "Leading stokers and eventually mechanicians will be selected from the most capable of the trained stoker ratings. The future mechanician will be the watchkeeping chief petty officer, and will have seniority of command over other chief stoker ratings not so qualified. This substantive rating will carry with it the executive duties of watchkeeper in both engine-room and stokehold."

Here we see that the Admiralty have so little knowledge of the *raison d'etre* of the engineer in the engine-room whilst the ship is under steam, that the Board considers a stoker rating quite good enough to entrust with the complicated machinery of our great warships! Some years ago, a writer dealing with the gradual descent which had been effected by the Admiralty in the matter of watchkeeping in the engine-room, from the engineer officer to the chief stoker, made the following remark, which would seem to be about to be fulfilled: "What is to hinder some future Board of Admiralty taking yet another and another step downwards until we reach that *reductio ad absurdum,* the stoker second class, as the final and ultimate substitute for the engineer officer of 1863?" There is nothing easier than to take a downward step, and successsive Admiralties have exhibited a marvelous facility in this art. The fact of the matter is that the retention of the engineer officer, or even his subordinate warrant officer—the artificer engineer—and the new Admiralty policy, cannot be reconciled; they will not coalesce. And so the stoker has had to be brought in, to try and make the oil and water mingle. As showing the contradictory policy of changing Boards of Admiralty, it may be mentioned that only a few years ago, the then Board issued a very stringent order that in future, a commisssioned officer was always to be in charge of the watch in the engine-room under steam. Owing to the reduction in the number of engineer officers in each ship, which had then recently occurred, this order compelled the senior engineer also to become a watchkeeper. It had always been a recognised canon in large ships that the senior engineer had quite enough to do in the general supervision of the department, and in carrying out the duties connected with the executive control of the staff, without being further burdened with watchkeeping; but the then Admiralty, moved thereto no doubt by the representations of certain nervous officers, who professed to have no faith in the engine-room artificers, issued the order referrred to. Now we have come to a time when the Admiralty consider that the engine-room artificer is too good for a mere watchkeeping chief petty officer, or warrant officer. At the time when the Admiralty issued the order above referred to, in which it was directed that a commisssioned officer was always to be in charge of the engines under steam, warship engines were much less delicate and complicated machines than they are to-day; and the constant attention and intimate acquaintance with the working of them is more imperative on the engineer officer than it has ever been in the past. Nor is this duty on the part of the engineer likely to become less needful in the future, although with the coming of the turbine some of the executive officers think that they will be able to do without the engineer altogether.

It is unnecessary to extend the limits of this paper. Enough has surely been written to show that the present policy of the Admiralty is calculated to endanger the efficiency of our warships in their most vital part, that of the machinery; and if that goes wrong, the most capable naval commander will be helpless to keep off a lee-shore, or to show a fair pair of heels to the enemy whom he is unable to engage.

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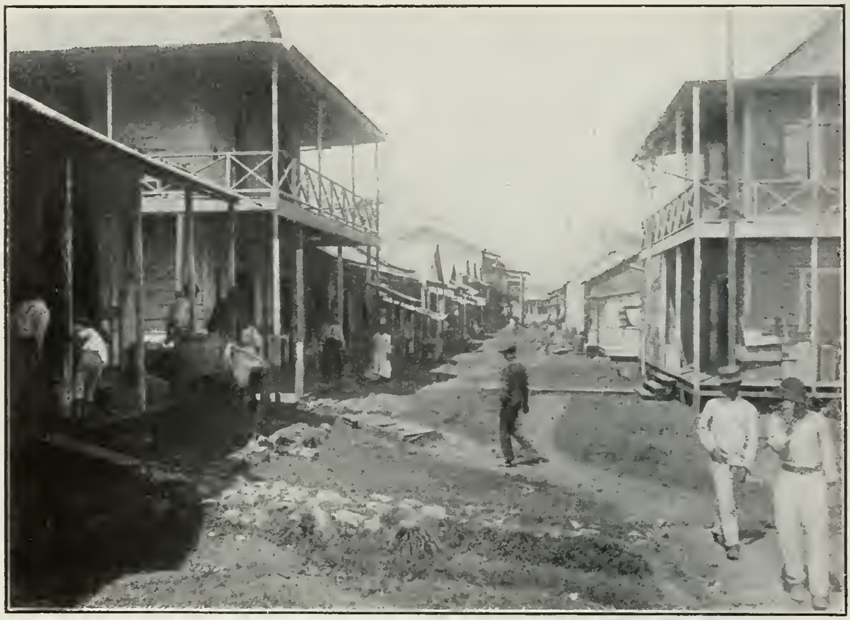
A BACK STREET IN COLON, SHOWING UNSANITARY CONDITION OF NEGRO QUARTERS. Six large families live in the house on the right, and in the large building on the left fifteen or eighteen families are surrounded by filth as shown in the picture. The negroes have no idea of cleanliness, and it is in these quarters that the work of the Commission is most difficult.

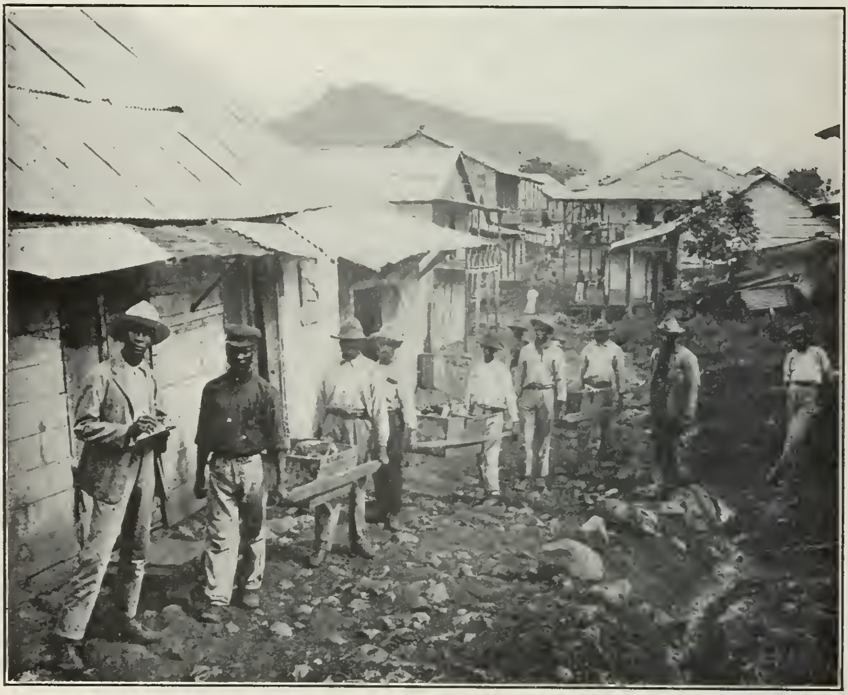
PREPARING THE ISTHMUS FOR CANAL CONSTRUCTION WORK.

By Fullerton L. Waldo.

It may reasonably be hoped that decision on definite plans for the Panama Canal is very near, and that before long construction work in accordance with them will be under way, with the energy and purpose which come from a settled mind and a clearly visualized objective. But it should be fully understood that, so far, no time has been lost. The two years which Mr. Morison presaged as indispensable to the work of preparation, before any large working force should be assembled on the Isthmus, have not yet elapsed. How fully they have been utilized Mr. Waldo's text and illustrations help to show. The subject is perhaps the most important, so far as the field work is concerned, at the present stage. His account has that sane balance between official gloss and sensational attack which attracted so much attention to his description of "An Engineer's Life on the Isthmus" in our issue for December last.—The Editors.

COLONEL W. C. Gorgas, of the medical corps of the United States Army, chief sanitary officer of the Isthmian Canal Commission, has been doing a piece of sanitative work on the Isthmus comparable only, in ancient fable, to the labor of Hercules in cleansing the Augean Stables, or, in modern history, to the work to which Colonel George Waring literally gave his life at Havana.





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THE WORK OF THE SANITARY COMMISSION IN CLEANING CULEBRA.

The upper view shows Main street after the work is finished. The lower one illustrates the garbage gang at work. The men get $2.08 silver per day, and the foremen $75.00 silver per month. Note garbage cans shown in the background.

If one confines one's observation to a very limited field for a very brief space of time, it is perfectly possible to find in some quarters the sanitary conditions which are shown in the first illustration. The picture represents houses of negroes at Colon. Six large families live in the bottle-hung villa to the right, and from fifteen to eighteen families exist in filth and miscegenation in the two-story structure on the left. The picture speaks for itself. But it should be said, by way of a gloss, that the Commission have to make up for four centuries of absolute sanitative neglect on the part of the Spaniards and the French. There had never been a bit of plumbing, or a sewer, on the isthmus. So that Gorgas and his men have had to institute a drastic cleansing, in the face of popular indifference, if not opposition, among the very persons who should have been most interested in furthering their efforts.

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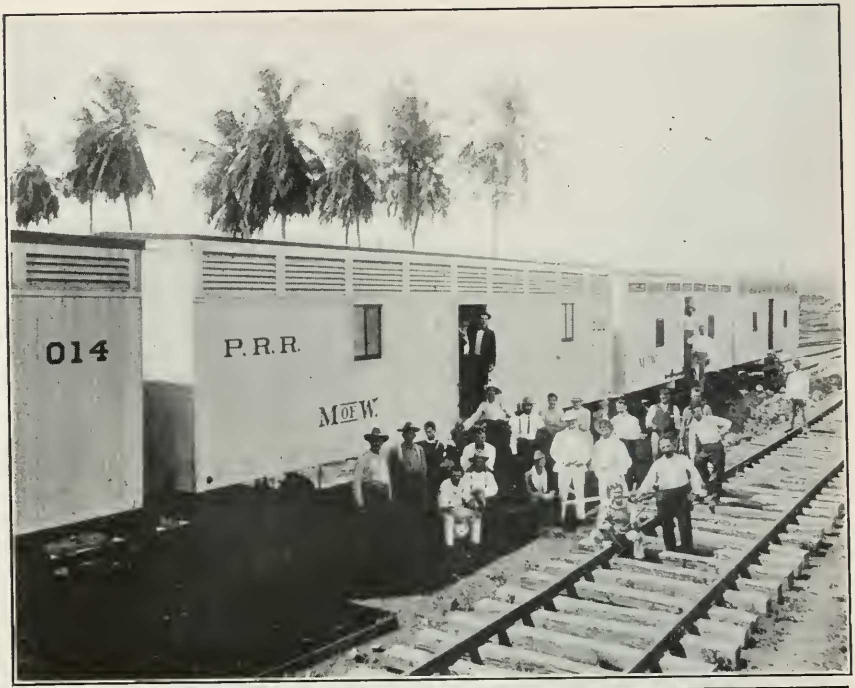
CUTTING WEEDS, MARSH GRASS, AND OTHER RANK GROWTH ON THE EDGE OF COLON.
This entire field is one enormous bog or marsh into which it is impossible for a horse to go, and which affords ideal breeding place for the mosquitoes. However, in spite of all this, the work of the Sanitary Commission has been so thorough in its fight against the mosquito that but few are seen or heard in Colon.

For instance: in the month of November 2,000 rats—peddlers of disease germs—were caught and killed on the wharves of the city of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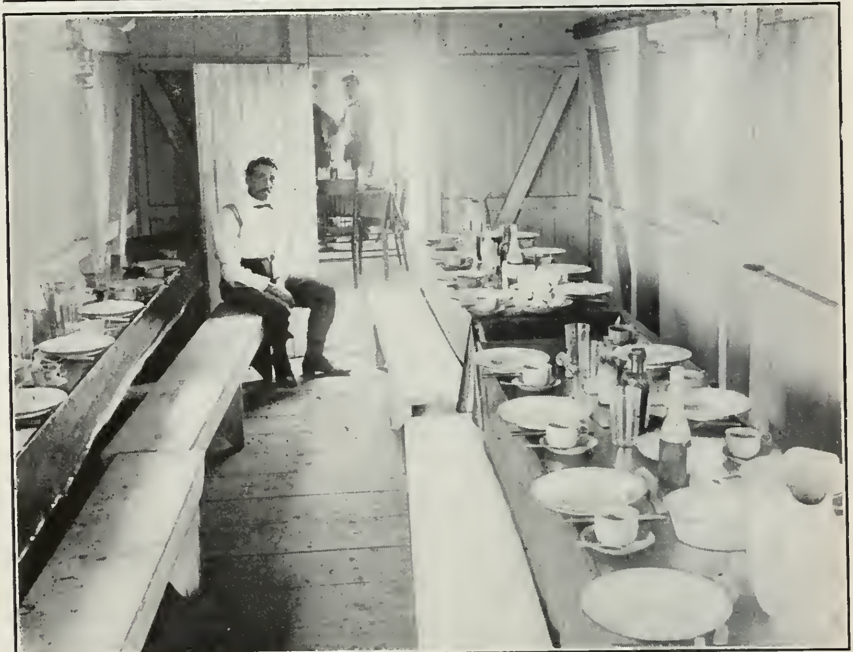

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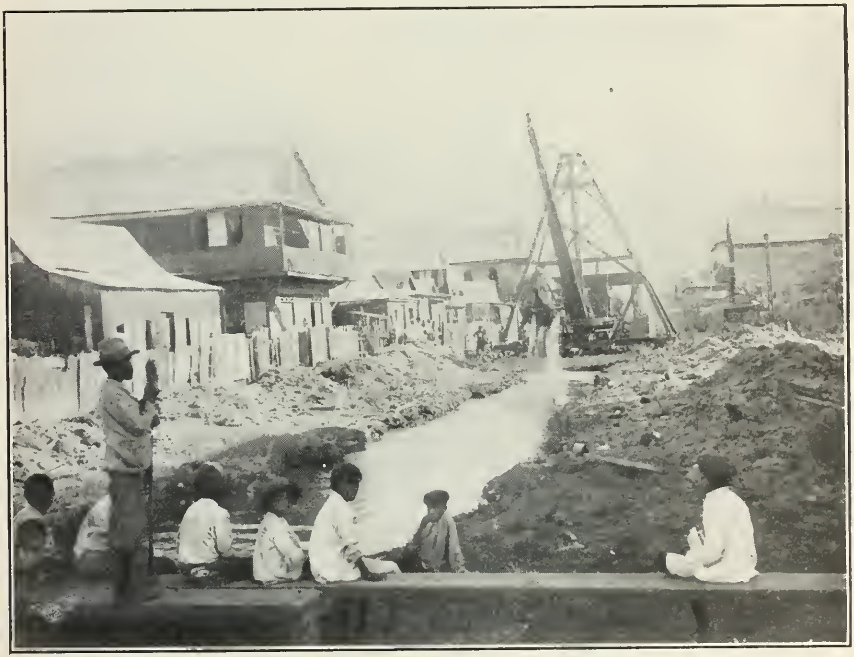
EXTERIOR AND INTERIOR OF CARPENTERS' AND MACHINISTS' DINING CAR, PANAMA RAILROAD.

The P. R. R. furnishes cars, cook, fuel for cooking, and the men provide the food, which costs about 60 cents per day per man. These cars are clean, cool, and comfortable, although somewhat cramped. The meals usually consist of soups, two kinds of meat, two (sometimes three) kinds of vegetables, good bread, jams, and preserved fruits, as well as fresh fruits, coffee and tea, dessert, the usual relishes, etc.

Panama; 231,440 gallons of pure drinking water were distributed in carts in the city, besides what flowed in through the mains of a reservoir opened (to the singing of the Te Deum) by the Americans, July 4, 1905; thirty-four hotels and boarding-houses were regularly inspected; 10,419 crab-holes were probed for lurking microbes; streets were repaired and spread with stone and gravel; pools and swamps were filled up; concrete drains were constructed, and ditches dug to carry off the polluted water from the supersaturated soil of the villages; dispensaries were established and hospitals built or effectively reorganized; 1,300 doses of quinine were administered daily; 2,200,000 square yards of brush and grass were cut and burned, in the campaign successfully waging against stegomyia and anopheles. Houses were fumigated, to a capacity of a million cubic feet. And all this was but a part of one month's labors of the "unheralded heroes" attached to the



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A CLAMSHELL DREDGE AT WORK ON THE SANITATION OF COLON.

Showing the amount of water in the soil on which Colon is built. These trenches will be connected with the sea, permitting a fast flow of sea water through the ditches. Roadways will be constructed on each side of the ditch. The dredge was constructed by division engineer's office, I. C. C., out of old French company's waste machines and stock timber. Native residences on sides (right and left). This work is carried on by division engineer's office for the Sanitary Commission.

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QUARTERS OF CANAL WORKERS, CRISTOBAL, PANAMA.

In the background are seen men at work improving the already good sewerage system, putting in new concrete gutters, etc.

Department of Health of the Isthmian Canal Commission. The results of it all appear in a succinct cable message, bearing date of February 16, to the Commission at Washington:

> "The report of Col. W. C. Gorgas, chief sanitary officer, shows the health conditions in January to have been excellent. There were 22,000 employees on the rolls. The average daily number of sick was 503, or 22 per 1,000. Seventy-four deaths occurred among the employees, including 26 from pneumonia, principally among negroes. There is no quarantinable disease on the Isthmus. The last case of yellow fever at Colon was reported December 11; the last case at Panama, November 11." (Signed) H. D. Reed,
>
> Secretary to Gov. Magoon.

When the significance of these figures and dates is grasped, it is apparent that there has been a great campaign fought through to victory—a campaign that consisted largely of

"Getting rid of dirtiness, getting rid of mess,
Getting rid of doing things rather more-or-less,"—

a campaign against cumulative conditions that would have stifled and paralyzed all possibility of doing any engineering work. No white man could live and labor on the Isthmus if this work had not been done.

An illustration on page 18 shows Main street in Culebra, after it had been cleaned up by the sanitary corps. The contrast with the condition of the negro quarters at Colon is refreshing, and shows what a transformation may be wrought. Many a village of (let us say) Southern Virginia is not half so well-kempt and orderly. The quarters of the married contingent of the canal workers at Cristobal, shown opposite, afford a more engaging picture of the domestic comfort attainable, on a simple and unostentatious scale of living, by the white employees of the Commission. The men seen at work in the il-

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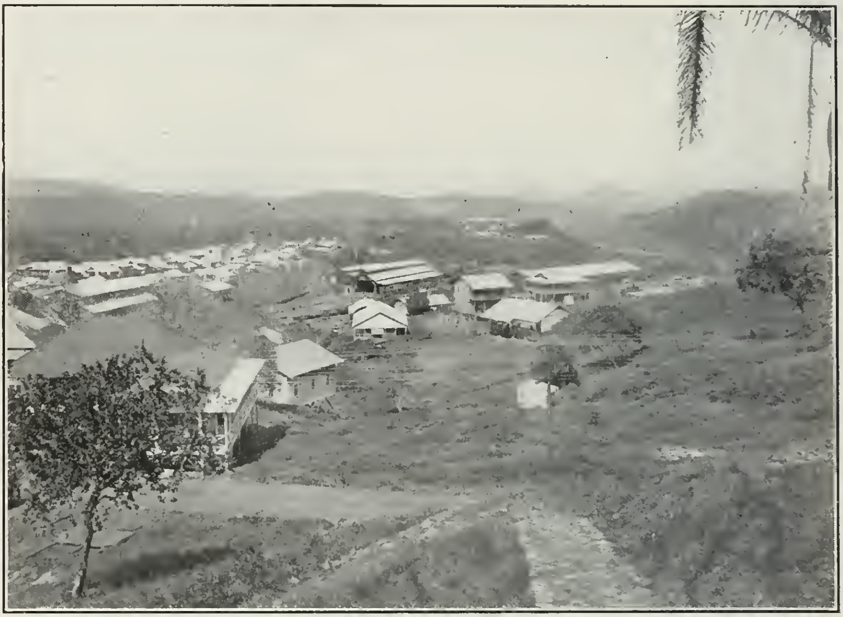
WASH DAY ON THE ISTHMUS.

Native negro women washing clothes in tributary of the Rio Chagres. These women do not believe in any of the favorite washing compounds, for their process consists of a severe rubbing in the hands and beating the work upon the rocks. These women get $3.00 silver per dozen pieces. A handkerchief counts the same as a white duck coat, and six pair of socks count as a dozen pieces.



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VIEW AT EMPIRE, SHOWING CLEAN AND COMFORTABLE HOUSES OF EMPLOYEES OF THE CANAL ZONE.

lustration are improving the sewerage system—which is already good —and putting in new concrete gutters.

The washerwomen of the Canal zone use the waters of the Chagres and its tributaries, wading far out into the stream and beating the life out of the clothing on the rocks. [See preceding page.] They do not use any of the washing compounds which, according to the advertisements, lighten the housekeeper's burden and make of wash-day a kind of festival. As can be seen from the illustration, the cleansing process consists of a vigorous rubbing between the calloused hands of the dusky laundresses. The price paid for the mangling is $3.00 silver per dozen pieces, a handkerchief counting the same as a fancy waistcoat, and a pair of socks counting for two pieces. It is easy to see why salaries on the Isthmus are double those paid in "God's country."

On the whole, the employees of the Commission are comfortably housed, in cool open-work shelters with wide verandas, adapted to tropical conditions. The older buildings in the town of Panama and the villages must go. The Spaniards were blind to the fact that the Roman basilica style of architecture is wholly unsuited to Central America. The Canal Commission had its offices till recently in one of these old stucco structures, damp and badly ventilated, with thick walls, harboring numberless yellow-fever mosquitoes in its neglected corners. They have just changed to new buildings at Culebra and Emperador. A hotel has been built at Corozal, between which point and the city American employees may use the railway at commutation rates, and at Ancon is another of 128 rooms. There are admirable hospitals at Ancon, at Panama, and at Taboga, an island ten miles out in the Bay of Panama, where pure water and recreative bathing may be had, with abundance of good fruit. The combined capacity of these hospitals is 1,000 beds. Mr. Isham Randolph, the distinguished Chicago engineer, says:

> "The hospitals are a source of just pride to our people. If sickness could ever be regarded as a boon, it may be so thought of in Ancon and Colon."

The hospital at Colon is built on piers extending out over the Atlantic, so that its patients get the tonic effect of the breezes from the sea.

The Commission took over from the French Company some 2,100 buildings, all in disrepair. They have repaired 649 of these, built 58 new ones, and started 67 more, in addition to the hotels above mentioned; 2,400 men are employed in the work of construction, and more builders and carpenters are being sent to the Isthmus on every steamer. Among the recent purchases of the Commission appear the items: 30,000,000 feet of lumber, 3,500,000 building brick, 500,000 square feet of roofing tile, and 36,000 barrels of cement. These figures partly account for the recent congestion of freight at the canal termini,—a serious obstacle to the furtherance of the engineering work.

OUTFITTING FOR THE PROSPECTING TRAIL IN NORTHERN MEXICO.

By Laurence M. Terry.

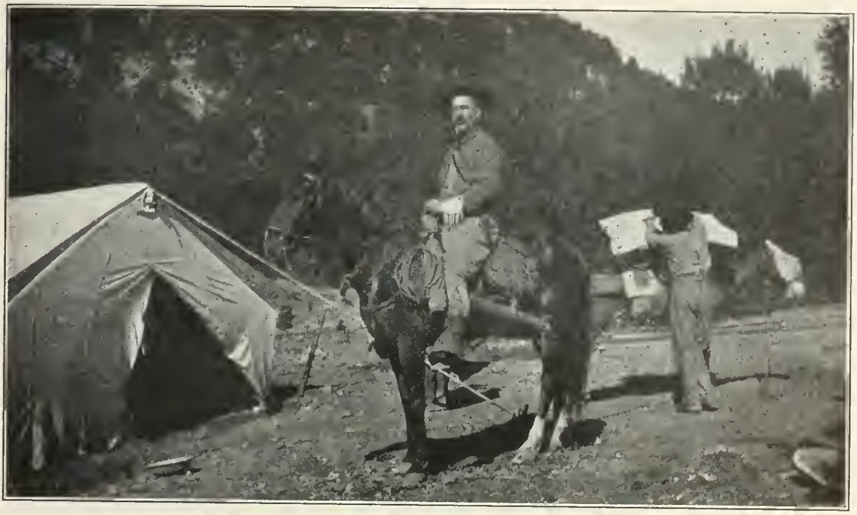
Mr. Terry's opening sentences indicate so clearly the interest which his theme carries for the engineer in the field that it is unnecessary to do more than add that he is offering the results of long and thoroughly tested experience. Such advice is most valuable, for it is rarely obtainable from a wholly disinterested source, and mistakes too often are discovered when remedy is too late. While Mr. Terry deals specifically with a certain region, many of the points will be of value anywhere.—The Editors.

DURING a ten-years' residence in Mexico, my attention has many times been called (and with no little incidental amusement) to the incongruity of the outfits prepared and brought into that country by those whose business, or pleasure, called them into the Sierras. So frequently has this been the case that a few suggestions from one to whom horse or mule-back transportation is a very old story, may not be amiss.

The average individual contemplating a considerable investment in mines, timber-lands, or other large enterprise, is naturally anxious to visit the scene of the projected operations personally, and for this class of travelers the following few pointers are given, in the hope that they may conduce to the comfort of both man and beast.

The climate of the State of Chihuahua, for example (a State which is largely visited in behalf of the above-mentioned enterprises) is much less equable than the plateau region to the south, and the choice of proper clothing and outfit becomes of prime importance. This choice is governed by the time of year selected for the proposed trip. In the warmer season, which may be taken to begin in April and to extend to about the first of October, it is the habit of the writer to provide himself with the following:—

Three suits of light underclothing, two suits of light-weight pajamas, six pairs of light woolen socks, two light-weight woolen shirts (being careful to get the best grade, for even these shrink all to much), a cravat or two and a dozen handkerchiefs, two pairs of hob-nailed shoes 12 inches high, laced with belt leather lacings through eyelets—not hooks—such as are made by Hanan or Putnam; two pairs of riding breeches, one of khaki and the other of whipcord, made very loose from the knee to about 4 inches below the waistband (which should



THE AUTHOR, IN SINGLE RIG SADDLE.

Showing pommel slicker in roll in front of saddle; *tapaderos* on stirrups; rifle and scabbard. Pack mule equipped with *aparejo* is being loaded in the background.

be just above the hip bones) and fitting snugly from there to the waist, also buttoning snugly from the knee to well below the calf. Two coats and waistcoats with plenty of buttoned pockets, to match the breeches, will pretty well cover the personal outfit, with the exception of toilet articles (of which later), hat, and gloves.

A wide, soft-brimmed Stetson hat, and gray buckskin cavalry gauntlets, or officers' style (Gloversville, N. Y.) gray buckskin gauntlet gloves give the best possible satisfaction, and pipes and plentiful supply of tobacco should not be forgotten by smokers, since the native pipe-tobacco is poor. Finer cigars and cigarettes than the Mexican brands, however, are difficult to obtain.

I have been criticised for advocating the use of hob-nailed boots in the saddle; but if one uses *tapaderos* on the stirrups, the danger of being hung up and dragged, in case of a fall, is reduced to a negligible quantity; and as all experienced trail riders make a practice of walking down all steep hills, the use of hob-nailed shoes, once adopted, will never be discontinued. The nails used should be small, round-headed Hungarian nails, and they should be put into the well wetted sole, heel, and also in the hollow in front of the heel, but should not be too thickly studded. Then treat both pairs of boots with viscol, to make them waterproof; and by all means carry a small can of it with you, for renewals.

In addition to the above personal outfit, a pommel slicker is an absolute necessity; and a laced-neck sweater is very apt to be needed on chilly evenings.

The toilet articles should be cut down to two bath towels; toothbrush and tooth powder; soap (I prefer "Ivory," which can also be used for shaving) in a metal soap-box; two razors, strop and brush, comb and hair-brush, and toilet-paper.

For a winter outfit, the addition of a reversible coat (of brown leather on one side and corduroy on the other); a change in the weight of underwear (if this is the custom of the individual), the substitution of heavy overshirts, pajamas, and woolen socks, with the addition of two pairs of heavy Shaker woolen socks for sleeping purposes, will be in order.

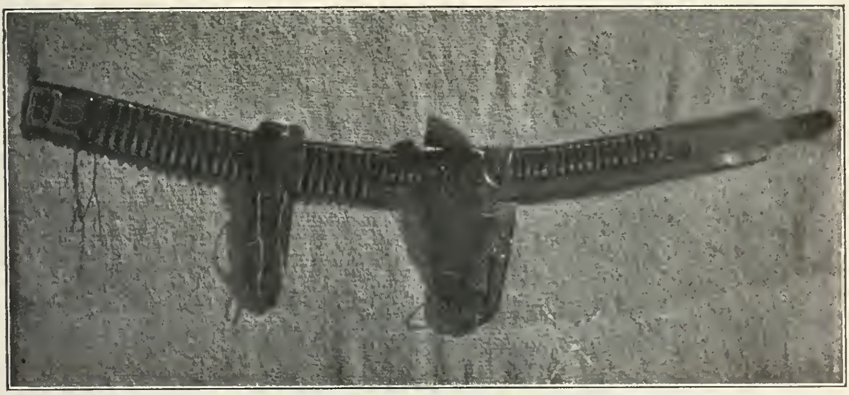
This character of outfit avoids the use of leggins, which at least to my way of thinking is a distinct advantage.

Among the articles which are not absolutely necessary, but which I always carry, are low slippers which have had an additional thin sole sewed on. It will be found that in dressing and undressing, as well as for any moving about at night, these prove to be an unmixed blessing.

Having attended to the clothing and toilet articles, the next thing confronting the "tenderfoot" is a choice of armament. Here there are nearly as many ideas as there are individuals. However, it is an undoubted fact that all of the expert pistol-shots (and by this I do not mean target-shots) of the West use the Colt .45 single-action, Bisley model pistol, and this gun, with the new smokeless ammunition adapted to it, is very hard to improve upon. The pistol belt should be made amply long, so that the gun may swing well down on the hip, and should be arranged to hold pistol cartridges for three-quarters of its length, and rifle cartridges for the remainder.

The holster should be a stiff, two-strap one, for nothing is more trying than a soft flap holster which lets the pistol pound you black and blue with the motion of the horse, and from which it is impossible to pull the gun quickly, in case of need. A five-inch Marlow knife and heavy stiff scabbard on the belt is a very useful tool to carry, but the thin glove scabbard which comes with it should be thrown away, and one similar to that shown in the accompanying photograph should be used instead.

A choice of rifles is a matter of individual preference, but a half magazine, round 26-inch barrel, .33 Winchester cannot be improved upon. There will be no need for anything but soft-nosed bullet cartridges, so provide these only. With the rifle will be needed a saddle



BELT, WITH PISTOL AND HOLSTER, KNIFE AND SCABBARD.

scabbbard, and the arm should be carrried with the sights up, thus avoiding deranging or breaking them. Probably a hundred pistol cartridges and forty rifle cartridges will be an ample supply, though if one intends to amuse himself by shooting, more than this quantity will be in order.

The choice of saddles, bridles, etc., comes next on the list; and with most people, it seems to be the usual custom to trust to luck, and count on getting a saddle at the trail starting-point. For a man whose combined Pullman and automobile cushions during a period of weeks will be a saddle on the hurricane deck of a mule, this seems to be a most short-sighted policy; for the Mexican saddle is at best an uncomfortable affair, and for the first few days, the finest of saddles will convince its user that it is no down pillow. By all means bring your own "proved and true" saddle into the country with you. You will have to pay a duty of two dollars Mexican money for each kilo of its weight, or about 45 cents United States currency per pound, but the money will be found to be well expended. What particular make of saddle you use is a matter largely of individual preference, with one reservation—never attempt to ride an English saddle in the mountains! The choice of almost all trail riders seems to be a double-cinch cow-saddle weighing from thirty-five to forty-five pounds, but this has a pommel which, being originally designed to serve as an aid in roping cattle, is of no particular use or benefit on the trail. In fact, I should find it a good deal of a nuisance, since I carry a slicker in a long roll strapped on the front of the saddle.

In getting a saddle, care should be taken to have it amply wide at the withers, for many of the Mexican mountain horses are both high and wide at this point, and if the saddle bears on the bone, a saddle gall will surely result. Let the tree be large enough to be perfectly comfortable, and have the cinch rig double. A usual fault in eastern-made saddles is that the cinches (or girths) being designed for American horses, are too long for the smaller Mexican stock, so have the cinches proper about 26 inches long, which will be found to work well in practice. Provide, also, a pair of light but strong spurs, with chain —not leather—to pass under the instep.

Get a single big bridle with a short-ported bit, so that your animal can drink without first having his bridle removed. There is on the market a combination halter-bridle in which the bit snaps onto the bridle with snap hooks, making a very useful combination.

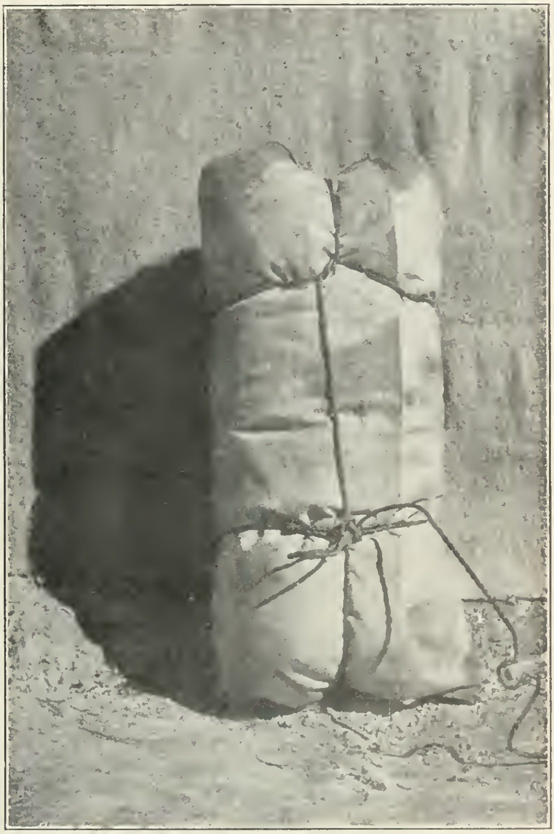
The saddle blanket may be a folded single blanket, or preferably a black woven-hair, leather-bound, shaped saddle blanket. This latter is on the Eastern market. Do not get a felt saddle blanket, as such an article rarely, if ever, proves to give good satisfaction.

It is a good plan to provide a canvas bag, with lock, for the saddle outfit, instead of packing it in a trunk. This need not be taken on the trail, but will serve to prevent injury to the saddle and will keep the outfit together in transit.

Get a pair of leather and chain hobbles, and put them in the saddle bag. When you see your pack mules driven into camp in the gray of the morning, chafed raw from the rope hobbles used by your native servants, you will be glad of your foresight in getting the improved articles; if you are not, your riding animal will be.

When it comes to the selection of a bed and bedding, it is easy to err on the side of too little bedding! In the first place, provide a folding canvas cot. This folds up so as to pack readily, and should not be omitted. For the summer trip, take four fairly heavy double blankets and a pneumatic pillow. This may seem excessive, yet I have slept cold with the same equipment as late as the end of May. Take no sheets. These latter are a nuisance, and it is remarkable how soon one forgets to want them in camp. For winter travel, take at least six blankets.

In order to carry your bedding compactly, provide a strip of 18-ounce canvas, 4 feet wide by 8 feet long, and enough ⅜-inch rope to tie the roll comfortably. Lay the canvas on the ground, fold the blankets lengthwise on it, then place the slippers, toilet articles, sleeping garments, and, in fact, everything you will need in the evening and morning, on it, and roll into a tight roll, so adjusting the canvas that there will be an excess length of canvas on the final roll, thus protecting the bedding. Now throw a loop of the rope (it should have

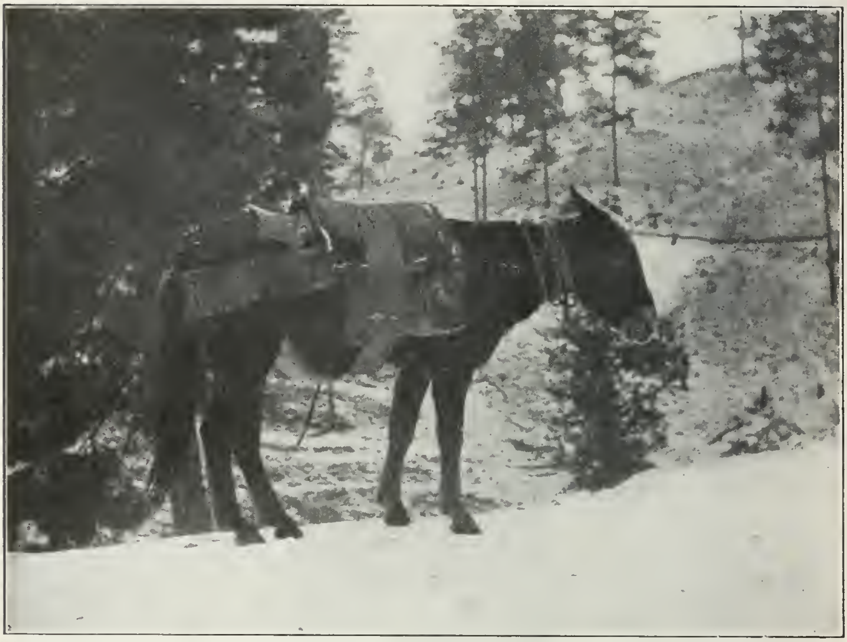


ROLL OF BEDDING, SHOWING METHOD OF TYING.

an eye-splice in one end) around the roll, and pull tight. Set the roll on end and fold the canvas in *a la* wrapping-paper; pass the free end of the rope over this end, take a turn in the loop first thrown; throw a half hitch around the roll near the other end; turn the roll end for end, tuck in the remaining end and pass the rope over it; take a turn in the nearest crossing rope and tie to the up-going strand from the first loop thrown—and your bed can go through anything (except rivers) without trouble or damage. For the carrying of your remaining plunder, use a "war" or duffle bag, preferably cylindrical in shape, and locking with a padlock.

The size of tent to be used will depend largely upon the size of your party; but let it be of thin patent waterproof material, an "A" tent in shape, and arranged to be slung from a rope stretched between two trees; and let it be as small as possible. There will be no necessity to provide a rope for stretching the tent, since the rawhide pack ropes used by the *arricros* (muleteers) are better than anything else for the purpose.

The usual form of packing appliance in this country is the *aparejo,* which invariably galls the pack mules on the back, and at the root of the tail. Aside from the cruelty to the animals, the prevalence of blow flies (causing screw worms in the raw places) at times causes the death of the afflicted beast, though this applies only to the summer



PACK MULE EQUIPPED WITH APAREJO.

season. The only advantage of the *aparejo* lies in the fact that it is better than a pack saddle for heavy or unwieldy loads, such as barrels or very large boxes; also, in renting pack-mules for a journey, they are always furnished with the native *aparejos.* For such trips as are contemplated in this article, the American army pack-saddle, with breast-rig, breeching, and heavy saddle blanket, is a better and far more humane arrrangement. It should be provided with *alforjas,* or large pack-saddle pockets. This pack-saddle must be bought in the United States (as must also everything heretofore advised) and brought into Mexico with the travelers.

In figuring number of pack animals which will be needed it is well to take not over 150 pounds of load, exclusive of the pack-saddle or *aparejo*—or even less, per animal. Then the pack can be kept up with the riding animals, which is a marked advantage.

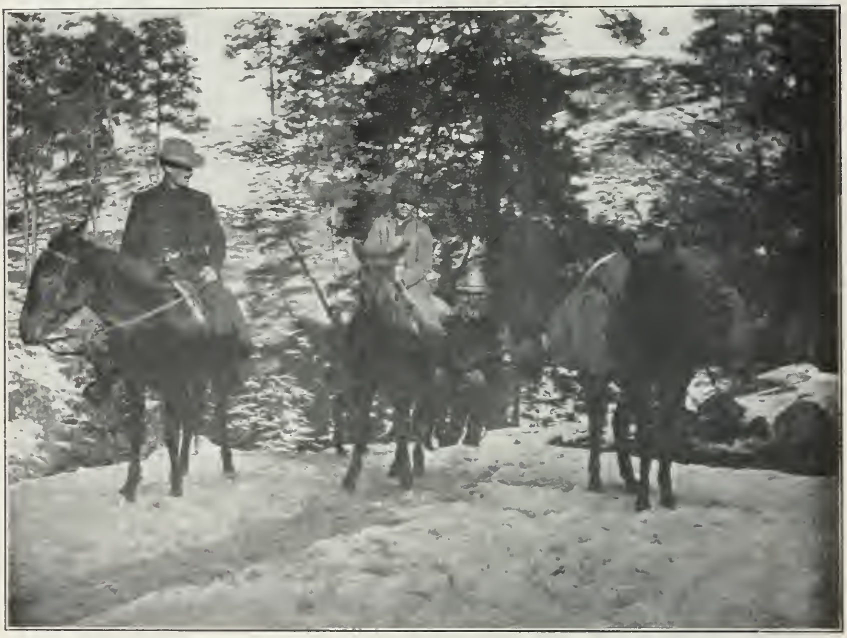
The food and cooking outfit usually presents difficulties to the tyro, and his common custom seems to be to have recourse largely to canned edibles. Now, tinned food, while good in its way, is heavy and bulky to pack, and moreover does not seem to be as well suited to the somewhat rugged needs of the *voyageur* as a simpler diet. I recall vividly a trip taken a few years ago where the food part of the outfit was left to a young and enthusiastic member of the party. At the first stopping place it developed that "food" to him meant sardines, corned beef, lunch tongue, *paté de foie gras,* etc., and while his assortment of tinned supplies was both large and varied, still, before a week of hard travel was over with, the entire party of us were more or less under the weather. At the end of this time we providentially reached a rather large mountain town and here we left the tinned dainties, providing ourselves instead with bread, *tortillas* (native corn, or rather ground hominy cakes) *frijoles* (the native bean) fresh and dried beef, etc. Result: in two days the whole party was well and cheerful again.

So confine your selection principally to simple and healthful foods. The list below will serve more or less as a guide, though it is impossible to give any ideas as to quantities, for this depends entirely upon the number of people in the party, the length of the trip, and whether it is the intention to pass through *pueblos* or towns wherein further supplies can be secured.

The traveler will need: Flour, candles, salt, sugar, pepper, lard, bacon, ham, coffee (already roasted and ground), tea, syrup or maple sugar—or *panocha* (native brown sugar) for making syrup for cakes—baking powder, canned butter, Mexican beans (*frijol bayo*), evaporated cream (unsweetened), soap, dried applies, potatoes, onions, rice, oatmeal (or any other cereal generally liked by all the members of the party), as much fresh beef as can be carried and will keep, dried beef (American) for party, and native (or *carne seca*) for the servants; some dried peppers (*chile colorado*) for servants, vinegar;

PACK MULE EQUIPPED WITH AMERICAN PACK SADDLE.

while for lunches, such canned food as may be deemed best may be provided. Matches, in some water-tight receptacle, must not be neglected.

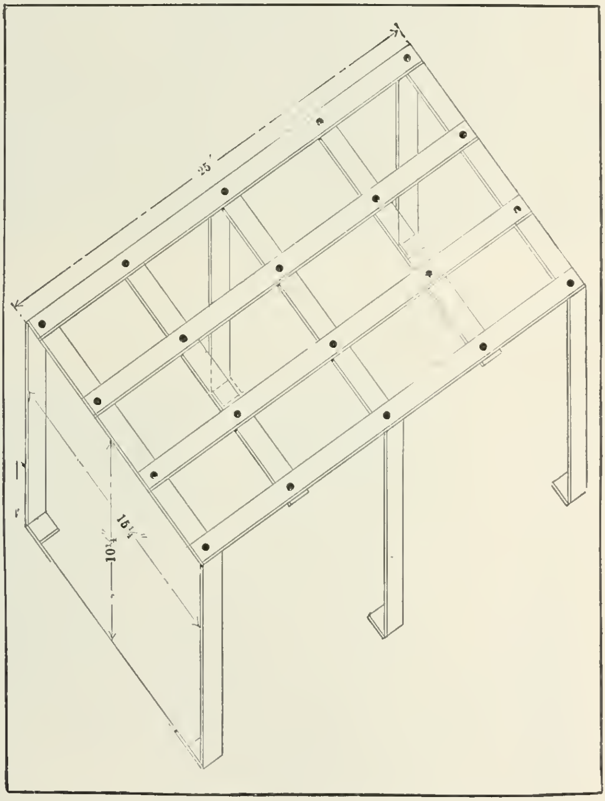


ENGINEER AND OUTFIT, SHOWING FLAT METHOD OF FOLDING AND CARRYING BEDDING.
This method is frequently used when it is not necessary to carry food or cooking utensils —as, for instance, on short trips between established camps.

If pack-saddles are selected for the trip, most of the provisions will be carried in the *alforjas;* but if *aparejos* are used, then strong boxes are about the most desirable articles in which to pack the food supplies. They should be rather long, not too wide, and should not be deep. About 30 inches long by 15 inches broad by 10 inches deep outside measurement is a good size, and easy to pack. They should have hinged covers and be provided with a hasp and padlock each.

The cooking and table outfit should be cut down to about the following for each person: one each, knife, fork, teaspoon, dessert spoon, enamel-ware cup, saucer, and soup plate—which latter serves equally well for soup, fish, roast or breakfast cereal! Then, for the mess, several extra soup plates for holding cooked articles, as well as a few tablespoons, and enamel-ware wash basin. Axe, hatchet, a butcher knife, a large wire fork; two or more frying pans; a Dutch-oven for baking bread; a large galvanized-iron water pail; a large stew pot and at least two small stew pails; a large shallow tin pan for mixing bread and biscuits, as well as a pancake turner. And last, but very important, a cross-barred iron frame, with legs, to set over the camp fire to support the cooking vessels will be needed, as also a coffee pot and tea pot.

The entire kitchen outfit should be packed in a strong box such as already described, but which is provided with a short stick which will fit into notches cut into the cover and back in such a manner that the covers may be opened out and held in a horizontal position by the stick, thus forming a small table. Two 4-foot squares of 12-ounce canvas will serve as table-cloths, being spread upon the ground.



GRILL FRAME MADE TO FIT OVER GRUB BOX.

The food can all be bought at the trail starting point, as a usual thing; but it is perhaps safer to secure all food and cooking supplies at the United States border city,—El Paso, if coming in via the Mexican Central Railway, or preferably San Antonio, if entering via Laredo.

The grill frame can easily be made by any blacksmith, and if made to the sizes given, will slip over the cook-outfit box, thus taking no extra room in the pack. One should always carry a few simple remedies, such as vaseline, quinine, brown mixture tablets, good liver pills, and castor oil, as well as whiskey. Prompt attention to such afflictions as colds, coughs, and chills will often prevent disaster, for in the high, cold altitude of the Mexican Sierras, colds develope into pneumonia

A PROSPECTING OUTFIT ON THE TRAIL.

with terrible rapidity, and pneumonia is as much to be dreaded as yellow fever. Also provide a mixture of half carbolic acid in crystals and half gum camphor. This last, when mixed, forms an oily liquid which is a certain remedy for screw worms, galls, and cuts on men or animals. Some tallow with which to grease the *aparejos* is also a useful thing which should not be forgotten.

In the warm valleys and gorges, and at times in the cooler heights (during the summer months) a small but persistent gnat, called locally "*jején*" is very painful and annoying. Its bite leaves a pronounced swelling, and when this subsides, a small black spot remains for days. Oil of cloves keeps these gnats off effectually and also discourges fleas, which are at times very insistent; while the carbolic-acid-camphor mixture relieves the intolerable itching caused by the gnat bite.

In setting out on the trail, it is wise to agree upon the various duties to be performed by the different members of the party, and then decide upon some one member to direct the entire outfit. If one man's duty is to cook; another's, to erect the tent and arrange the bedding; and a third's to see that the animals, saddles, etc., are properly cared for, later washing the dishes, there will be no confusion when going into or breaking camp, and arguments will be thereby avoided.

It is advisable to take at least two foot-*mozos* (native servants), though for a large party with a considerable pack train, more will be needed; and it is to be remembered that if the native servant is given an inch he will expect—and promptly take—the proverbial ell. His food consists of coffee, bread (or *tortillas*), sugar, fresh or dried beef, peppers and beans. If you give him milk or butter, you will later have trouble with him; and there is a saying that the *mozo* who wears shoes and who speaks a few words of English is good for nothing. Experience proves this to be a very sound saying; so pick out sandaled *mozos* for your trail servants, and be happy.

From late June till early October, and frequently later, heavy rains are to be expected; and as the lightning is bad, care should be taken to pitch camp in a spot which will be free from this danger, as well as from falling dead trees. In the winter months, rain, hail, and occasionally as much as three feet of snow may be encountered. In deciding on a camping place, the first desideratum is good water, then grass for the animals, and lastly wood; and after pitching the tent, it should be ditched on the up-hill side.

As a final word, I would suggest that a small covered aluminum canteen of water be carried on the saddle, and that one make it a rule to keep his pistol on his person by day, and under his pillow at night. During ten years I have never been called upon to use a firearm—possibly for this very reason—for a show of force is probably one of the best means of preserving peace.

AT THE JOURNEY'S END.

ATHLETIC FIELD, FOR NOON-HOUR AND VACATION SPORTS.
Works of the N. O. Nelson Mfg. Co., Le Claire, Ill.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

IV. AUXILIARY METHODS OF SUCCESSFUL LABOR EMPLOYERS.

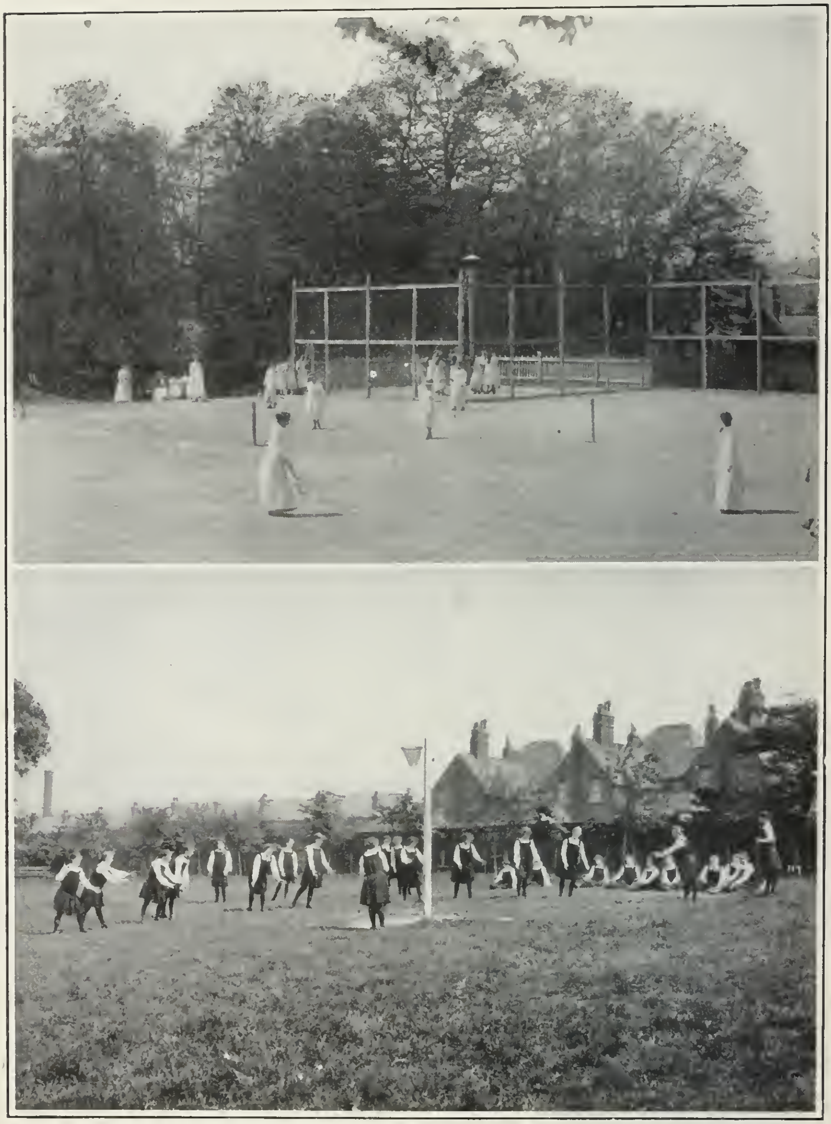
Mr. Becker's series began in the issue of this Magazine for January last; the first portion dealt with "the common-sense of the management of men"; the second took up adaptations of the shop—in matters of design, arrangement, or construction—suggested by modern ideas of the just relations between employer and employee; the third treated of institutions affecting more closely yet the physical well-being of the worker, as to nourishment, hygiene, and other matters formerly regarded as quite outside the purview of the employer. The installment following, which closes the present phase of the discussion, shows the progress made in many factories in the recognition of the social needs of their workpeople, and the sound practical economy which results from well advised effort along these lines.—The Editors.

EVERYWHERE in the physical world the phenomenon of fatigue under tension is acknowledged, even in the case of mental sections. Given intervals of rest—perhaps extremely brief—and no harmful strain results; but without the occasional relief for molecular or cellular readjustment, the steel rod, the animal muscle, or the human brain may collapse. It is generally recognized, by men whose work demands close thinking or even close attention, that there is a period, varying with the individual but fairly definite in the single case, throughout which concentration of thought or perception may be maintained; but that when the limit is reached, there must be a relaxation—perhaps hardly more than momentary—or the productive (or receptive) faculties drop in efficiency at a very rapid rate.

The whole trend of modern factory operations is toward increase of the nervous tension under which the employee carries on his work. The effort to increase production finds expression in high-speed machinery, specialization of the operations performed by any one operator, wage systems stimulating him to the closest attentiveness upon his job. It would seem only reasonable, in the interest of the maximum of effectiveness of each producing unit, that attention should be given not only to the highest output while working, but to the highest recuperative effect in all the intervals of rest.

AFTER-DINNER SCENE IN A FACTORY DINING ROOM FOR FOREWOMEN.
Cadbury Brothers, Bourneville, England. Their female employees are supervised by members of their own sex.

The noon intermission is in many work places so short, often but thirty minutes, that the question of a profitable disposal of surplus time does not arise. Half an hour barely suffices for getting to and from the lunch room and bolting a little lunch, leaving scarcely time enough for cleaning up before eating, even when the facilities for doing so are at hand. If, as is usually the case, there are no lunch-room conveniences, and the men are obliged to eat in the shops or from the street curbs, the time left is yet too short to be of any particular value for recreation. If the longer noon period prevails, as it should in all cases, a systematic effort can be, ought to be, and sometimes is made



OUTDOOR EXERCISE FOR WORKING GIRLS IN A LARGE FACTORY.

Tennis and "net ball" at the works of Cadbury Brothers, Bourneville.

to relax the tension of the workers. During good weather the men and boys usually manage to get some sort of relaxation out of doors. Usually no attention is paid to this part of the workmen's time by the employer. A few encourage the organization of base-ball and other athletic teams, and even help furnish the necessary supplies. Such

LIGHTENING THE DAY'S WORK.
Mechanical piano as a recreation feature. The Sherwin-Williams Co., Cleveland, Ohio.

recreation is necessarily limited to the few in the "teams," and has small value except as a promoter of loyalty and enthusiasm, because games must be played during holiday times mostly.

The lunch and rest rooms, when provided, furnish a fine opportunity for an extension of the in-door activities. With little additional expense, or none at all, such rooms can be used after lunch for smoking or recreation rooms. A few extra tables, supplied with papers and magazines, and possibly some games that do not require elaborate appliances, make a good beginning. The rest room for girls ought always to be thus supplied. No elaborate room is requisite to so simple an arrangement. It can be done with the crudest sort of place, if necessary. Naturally, however, a comfortable room fitted with suitable furniture and containing a case of books, in addition to the periodicals already mentioned, makes a more desirable place. The presence of a phonograph and set of records adds to the enjoyment. Some employers have put self-playing pianos into such rooms. In places where this is the case, there is usually dancing, if the floor permits. This is undoubtedly the most popular form of amusement (the excess to which it is often carried scarcely permits

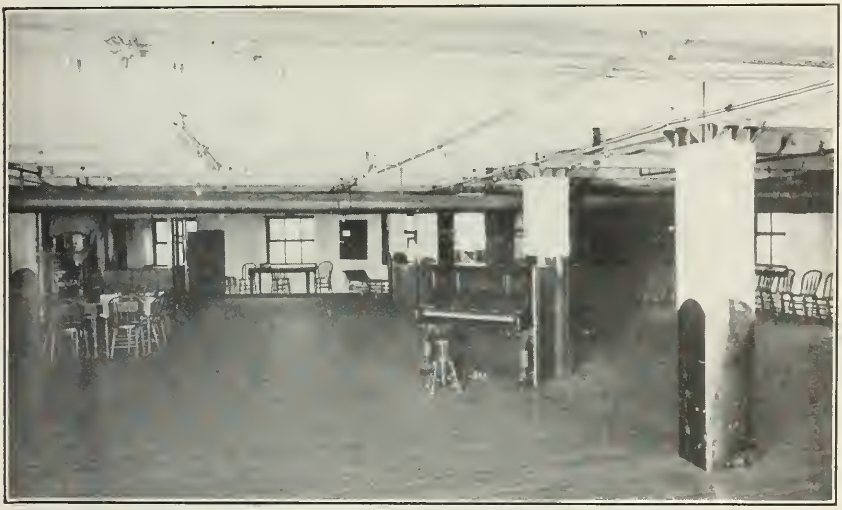
A WORKS RECREATION CLUB.
Sherwin-Williams Co., Cleveland, Ohio.

RECREATION ROOM FOR MEN.
Works of Lever Bros., Port Sunlight, England.

it to be placed in the category of recreations) among women workers; and when opportunity for it is offered, it is greatly appreciated. In a certain large factory about six-hundred girls make use of the lunch room during the early part of the noon hour, and having disposed of their lunches most of them are almost immediately dancing in the adjoining room. On the one day of the week when the men are admitted to the dancing floor it would be difficult to say which sex enjoyed the privilege most. Opening into both these rooms is another, cozily furnished with benches, couches, and rockers, to which those girls may go who are not in a dancing mood. Here also are periodicals and other things to give profitable occupation or relaxation.

RECREATION ROOM FOR MEN IN A MODERN SHOP.
The Weston Electrical Instrument Co.

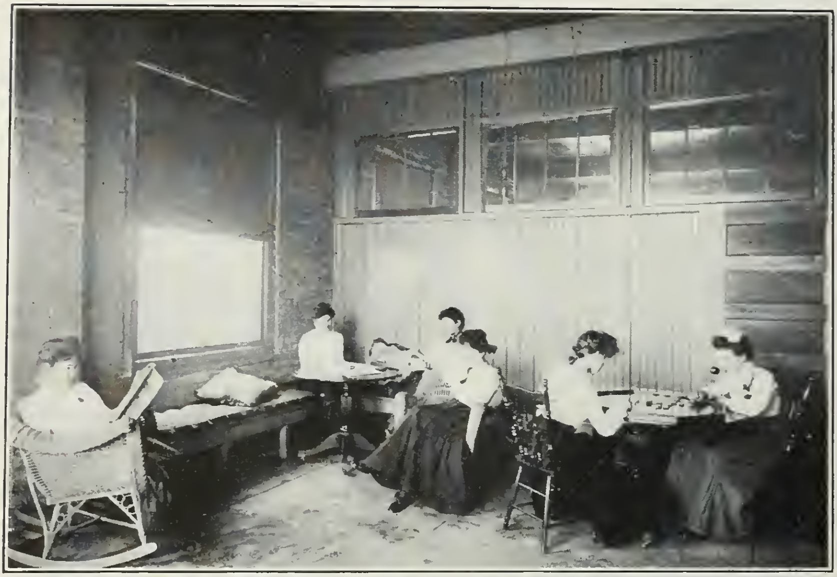
Such resting rooms are now come to be established institutions in most large industrial and commercial plants. One would say that their absence nowadays is indicative of extreme indifference to the comfort of women employees, to say nothing of the decencies. It may be nothing more than a suitable corner screened off from an office or shop, containing a few chairs and cots where girls may rest if weary, or lie down if ill. Usually it is a separate room, cozily fitted up, neatly decorated, and furnished with some ordinary conveniences. The decorations and pictures give it an air more homelike than that to which most of the girls probably are accustomed, and thus become effective agencies in the development of a better standard for the home life.

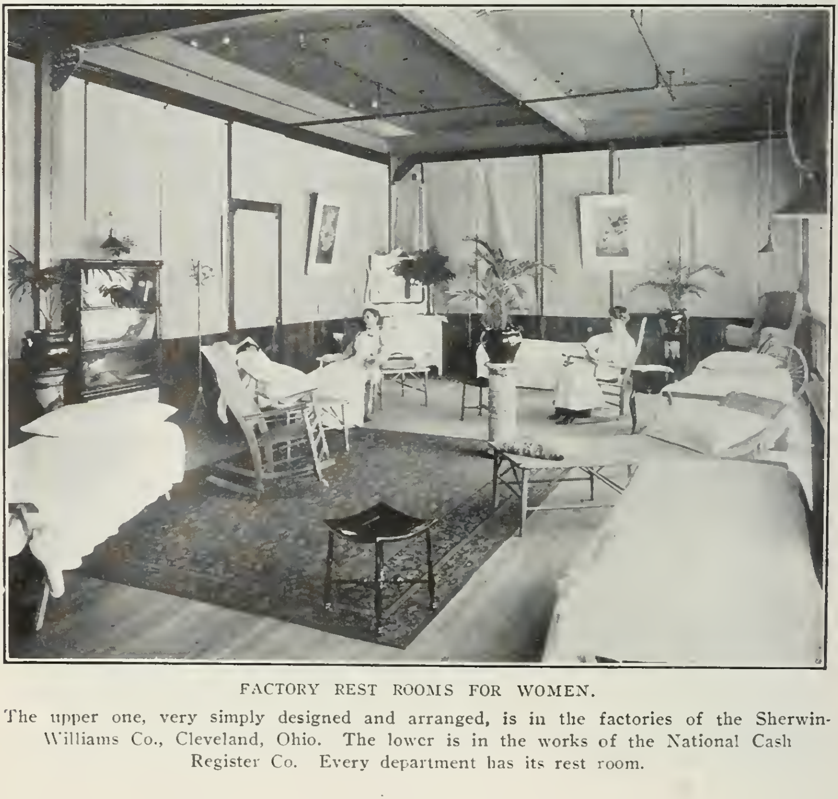


DANCING FLOOR ADJOINING GIRLS' LUNCH AND REST ROOMS.
McCormick Twine Mill, Chicago. Much used for recreation during the latter part of the noon hour.

The rest rooms for men are not as yet looked upon with favor, though there are notable instances where such have been used. Perhaps the name "rest room" does not well describe most of these. They are most frequently stopping places for employees of railroads and street car lines, rooms where employees may spend their time between trips, or when off duty. Naturally such places are supplied with books and other reading matter, and it is desirable that there be also other forms of amusement. But a room where a weary workman might rest, or recover himself if faint, is something for which the industrial world is scarcely prepared, though they are not so uncommon as may be supposed, particularly in Europe.

The weaknesses and ills of women appeal to the sympathies of managers, and the need for a resting place for them is pretty generally recognized. An hour's rest in case of sudden faintness or illness is often all that is required to permit of a return to work. The lack of





FACTORY REST ROOMS FOR WOMEN.

The upper one, very simply designed and arranged, is in the factories of the Sherwin-Williams Co., Cleveland, Ohio. The lower is in the works of the National Cash Register Co. Every department has its rest room.

opportunity to do so necessitates the loss of the remaining part of the day to both employer and employee, or an aggravation of the illness in the endeavor to continue at work.

Of course it often happens that the illness is too great to allow of immediate restoration; and there may be serious accidents. In such cases there is all the more need for a place of retirement while temporary relief is administered and arrangements are made for the removal of the sufferer. Under such circumstances the lack of a place of this sort is embarrassing, to say the least. A woman is no less modest because she works in a factory, and it is proper that her modesty should be respected as much as possible, even in emergencies.

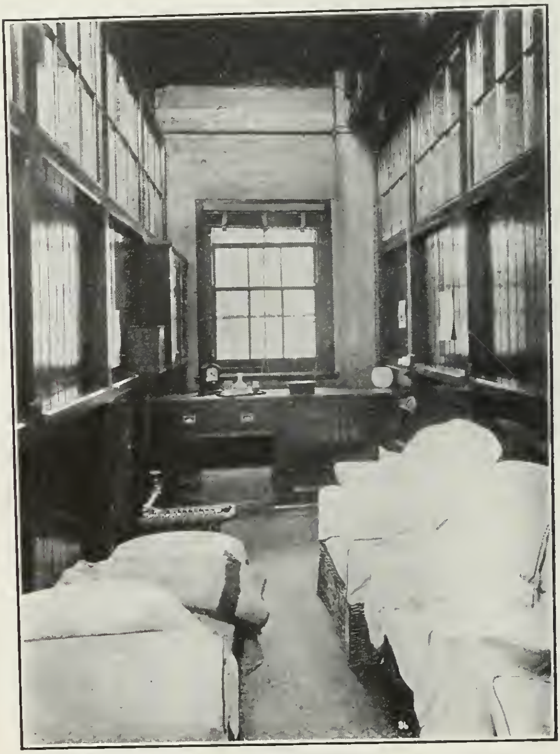
EMERGENCY ROOM IN A NEWLY BUILT AMERICAN FOUNDRY.
The B. F. Sturtevant Co., Hyde Park, Mass.

Caring for the injured and sick in a large plant is a matter of considerable importance, whether looked at from the humanitarian or the business point of view. The growing tendency of courts and juries to hold employers liable for damages in case of injury to the employee makes the annual payments in injury claims no small item. It is therefore a matter of economy for the employer not only to take all possible precautions, but to make ample provision for the care of their injured, if not of their sick. There are bound to be many small injuries in a large establishment, no matter how many safety devices

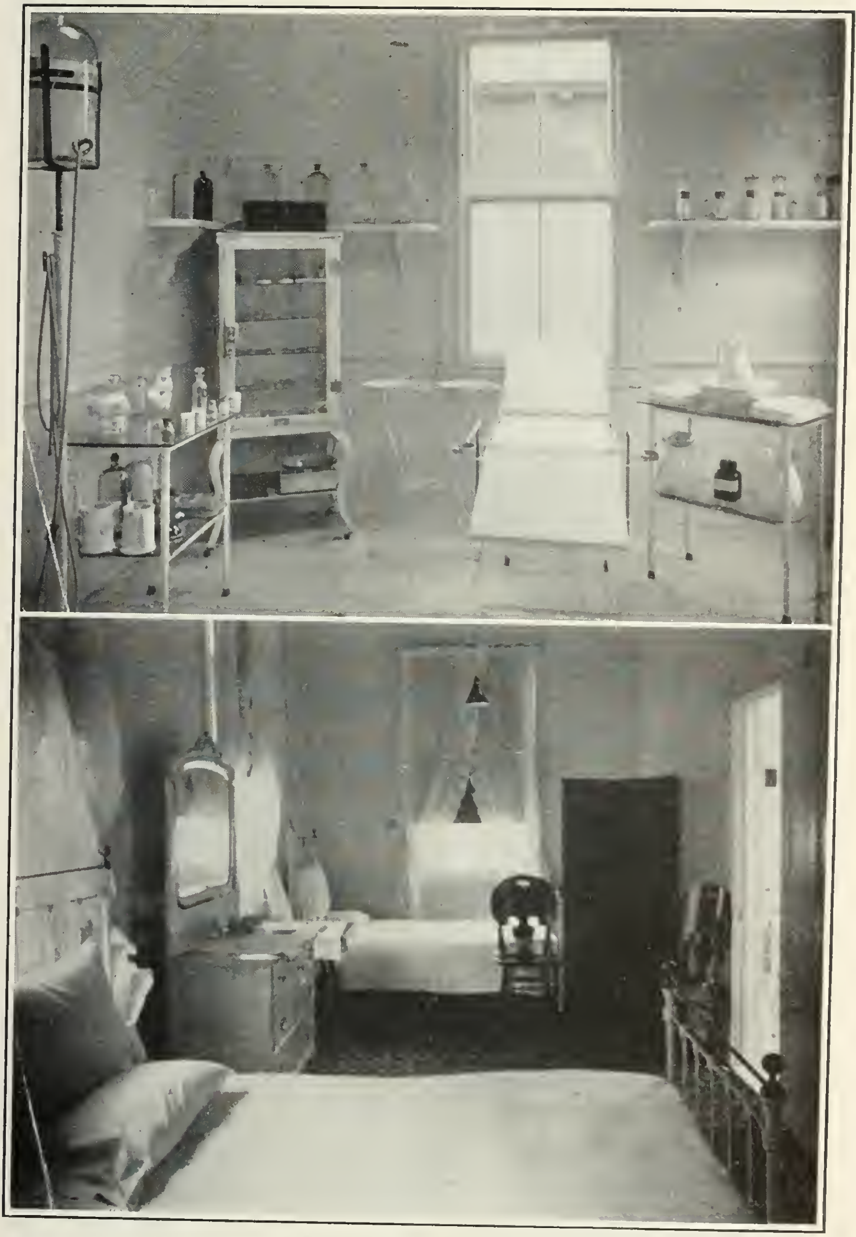
RECEPTION ROOM IN A FACTORY EMERGENCY HOSPITAL.

American Sheet and Tin Plate Co., Vandergrift, Pa.

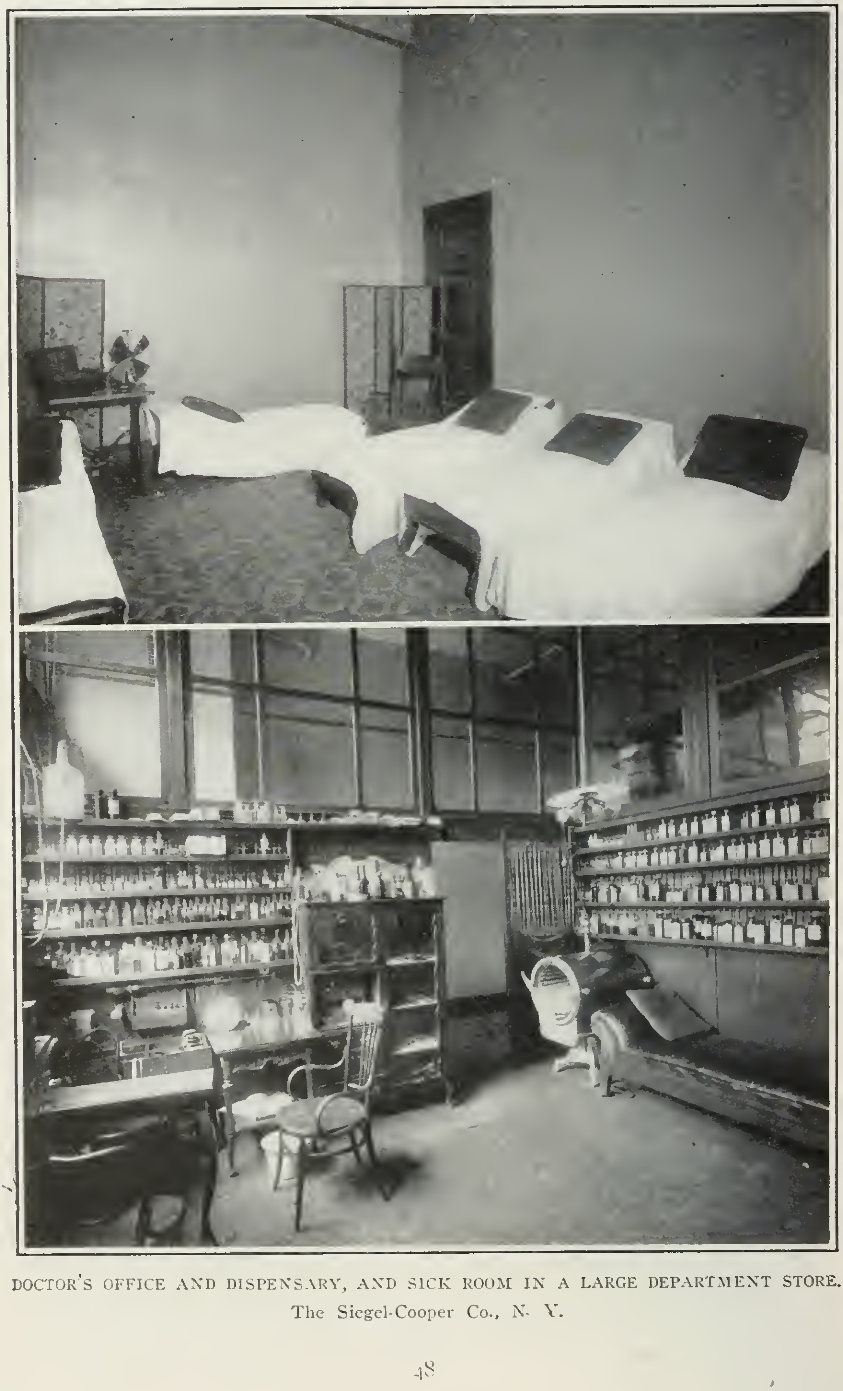
are in use, and no matter how small an injury may be, there is always a possibility of its becoming infected and leading to serious results unless promptly and properly treated. Emergency relief therefore is important from considerations of business economy as well as altruism. In Europe there is a wide-spread interest in the subject of first aid to the injured, cultivated in part, no doubt, by the stringent employers'-liability laws. There the knowledge of what to do in emergencies is not confined to physicians and to a very few laymen. Working people generally have become educated on this subject so that there is always some one at hand in case of emergency to take proper precautions and often thereby to save a life. In the United States the same subject is now receiving considerable attention, and a movement has



A RETIRING ROOM FOR GIRLS WORKING IN A SHOP. Bourneville, England. The smaller wall cabinet on the left is stored with supplies for emergency relief.



OPERATING ROOM AND BEDROOM CONNECTED WITH A LARGE ENGINEERING WORKS. The appliances include everything necessary for emergency operations. Serious cases are removed to a hospital as quickly as possible. American Sheet and Tin Plate Company, Vandergrift, Pa.



DOCTOR'S OFFICE AND DISPENSARY, AND SICK ROOM IN A LARGE DEPARTMENT STORE.
The Siegel-Cooper Co., N. Y.

A FACTORY WOMEN'S CLUB.
Lowe Brothers Company, Dayton, Ohio.

been set on foot looking toward the education of the masses in this important respect.

The employer, whether of many or few people, certainly owes it to himself and his business interests, as well as to those employees, to encourage such education. Many are already doing so. It is not uncommon to find in an establishment one or more persons who have some knowledge and skill in the first care of injuries—enough to give attention to injuries until a surgeon could be reached, should that be needful. Of course the first-aid man should have within reach a store of emergency supplies. The plan in vogue in some houses is to have suitable cases filled with necessary bandages, antiseptics, and other supplies in several parts of the works convenient of access.

It is usually desirable, particularly when there are no workmen with sufficient knowledge or experience to do such work, to give instructions in the subject. Where there is a house physician employed, or the employer has a contract with near-by surgeons, there is no difficulty in having the first-aid corps properly instructed and directed. They will naturally report to, and be under the instruction of, such physician. In those cases where there is no physician or competent director for such work, classes are organized, usually open to all who care to enter

WORKING GIRLS AT LUNCH.
Lowe Brothers Company, Dayton, Ohio.

SITTING ROOM AND NURSES OFFICE IN AN ENGLISH FACTORY.
Cadbury Brothers, Bourneville.

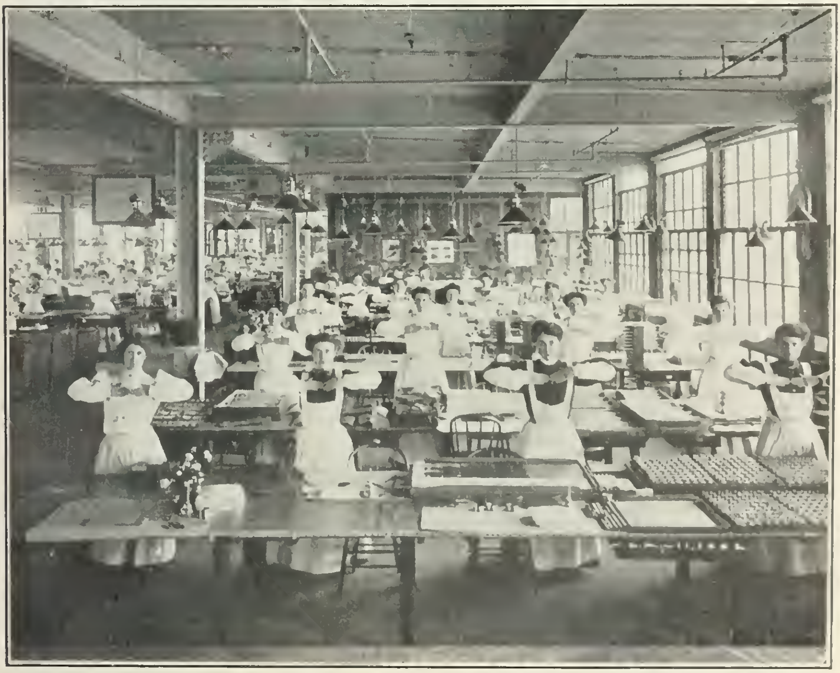
them, instructed by some one employed for that definite purpose. This is a very common course in England and Germany. In a short time the members of the class acquire sufficient skill to be entrusted with the preliminary care of the sick and injured. In small establishments this is about as much as can be expected, in addition to calling in a physician in serious cases.

Many concerns employ nurses or matrons, part of whose duties consist in this kind of work among the other women employees. In some instances this function is extended, and visits are made to the homes of those who are sick or absent from work. Working in connection with and under the direction of a house physician, this form of social service becomes of great value to employees, and employer as well. One great Chicago factory employs a visiting nurse for this purpose, in addition to two physicians and several matrons.

When the business is large enough to warrant the expense, the establishment of an emergency hospital in charge of a thoroughly qualified physician is almost of prime importance, and there are now a considerable number of these. They are usually equipped with modern hospital appliances and an ample dispensary, so that patients may be sure of receiving proper attention. As to the further management of cases, whether of sickness or of injury, practice varies. In some instances it is the custom to follow up every case and treat it in the patient's home or at the hospital (when desirable or necessary) with which arrangements have been made for the reception of the patients. Some large employers, notably the great railway systems, have their own hospitals, usually supported in part by the contributions of the employees. An interesting development of the emergency hospital idea is the hospital car lately put into service on the Southern Pacific Railroad.

Illness often arises, particularly among girls, from a cause usually not suspected. A case in point is that of a large employer of women who found that there was an alarming number of the girls leaving their work every day because of fainting spells or sudden illness. Upon careful investigation it was found that there could be but one reason for it—the long continued and close application to their work. It was decided to give them a short rest period at the middle of each half-day period. When this was done the trouble at once disappeared.

In some shops it is customary to make use of such periods of relaxation for simple calisthenic exercises which bring into play the

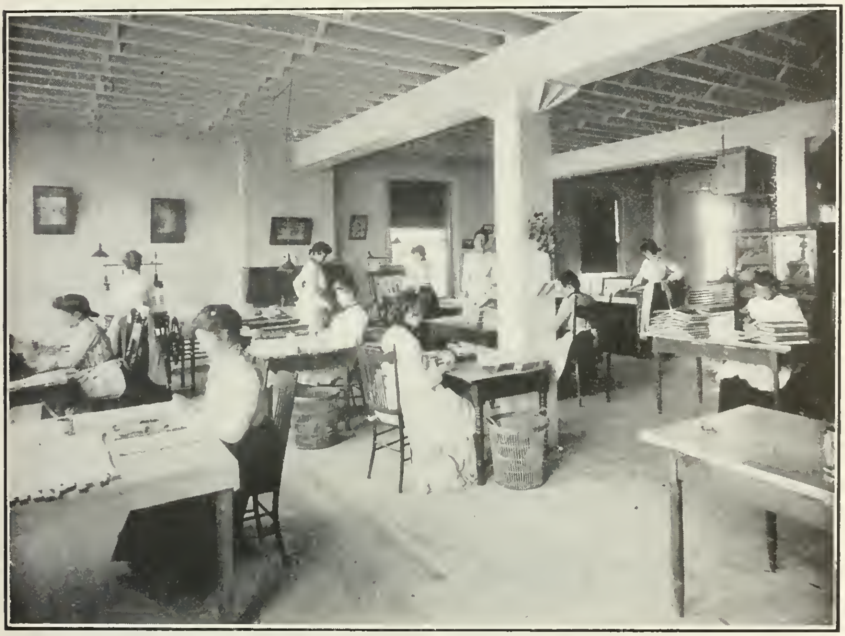


RELAXATION CALISTHENICS IN THE MIDDLE OF A WORK PERIOD.
National Cash Register Co.

muscles little used while at work, and relax the strain upon others. The girls then continue their work very much relieved. Such relaxation is especially desirable where the operatives have comparatively little freedom of movement or sit at their work. In some department stores as well as in other places of employment gymnasia have been fitted up for women, and occasionally also for men. The intention is that employees shall take a little time during the day, or at its close, to relax or limber up. Such places are undoubtedly useful; but unless the employees have a specifically allotted time, and are at that time under the direction of a gymnastic instructor, the gymnasia are found to be little used. What is necessary is, not elaborate rooms and equipment, but actual change in position and occupation for a few minutes, for all who do not get variety of muscular activity in their regular work. The work room is as likely as not to offer opportunity for this. There should always, however, be some one competent to do so, to lead the exercises. Otherwise there will be none.

INTERIOR OF MEN'S GYMNASIUM IN AN ENGLISH FACTORY.
A similar room is provided for women employees. Cadbury Brothers, Bourneville.

The productiveness of the worker, as has been already shown, depends very largely upon the nature of his environment in respect to those things that may be called the decencies, and those other things that look toward the conservation of his health and strength. There is one other factor of real importance, a factor that is all but universally overlooked or neglected, namely that of the environment in respect to the æsthetic nature. Doubtless there will be incredulous smiles among readers of these words. This factor nevertheless deserves much more consideration than it usually receives.



A PRACICAL AND PLEASANT WORKROOM FOR WOMEN.

Color-card room in the paint factories of Lowe Brothers Company, Dayton, Ohio.

Attention has already been directed to the certain effect of slovenly shop surroundings upon the workmen in it. Good light, cleanliness, proper sanitation, comfortable position while at work—these and other things have been indicated as helpful in making workmen cheerful, happy, and content. But a shop may have all these things and still be a dismal, cheerless place to work in, whose depressing influence cannot be entirely dissipated by the lively activity of which it is the daily scene. It is doubtless too much to suggest, at least under prevailing industrial conditions, that every place where men and women work should be made beautiful. The manager of a foundry or a rolling mill would very likely laugh outright at the idea of beautifying such places. Commonly located in busy, crowded, and dirty districts, gridded with railroad tracks and switch yards, the buildings as tall and close to each other as possible and frequently hidden in clouds of smoke and dust, the average factory looks very unpromising indeed from the æsthetic point of view. Experience has shown, however, that even under most discouraging conditions there are possibilities. The largest factory in its line in the world was ten years ago no exception to the general rule. Today it is throughout almost a work of art, internally as well as externally. The walls are painted, the newer buildings artistically designed, and old ones more or less reconstructed, vacant spaces not otherwise utilized sodded with grass, shop walls agreeably tinted and at intervals hung with pictures and appropriate mottoes. Shrubs and vines are everywhere in evidence, boxes of plants and flowers grace many a window, and trees are found where least expected. The whole atmosphere is more that of a studio than that of a factory as ordinarily known. And the owner asserts most emphatically that all this, along with the many other agreeable conditions he has brought about, has a powerful influence upon his operatives, making them better men and women and better producers; and in consequence that it yields good interest upon the investment.

A FACTORY ROOF GARDEN—A SUGGESTION OF WIDE APPLICABILITY.

Factory of the H. J. Heinz Co., Pittsburg, Pa.

There is no inherent reason why such conditions should not ultimately prevail very largely, or even universally. The further development of mechanical methods of manipulating materials will assist greatly in bringing about such a changed condition. The use of

GROUNDS AND BUILDINGS OF A MODEL FACTORY.

The east lawn "Ivorydale" (the factories of the Procter & Gamble Co., Cincinnati) on "Dividend Day," the occasion of the quarterly profit-sharing distribution. The key to the Ivorydale policy is the effort to enable the employees to better themselves financially.

mechanical and automatic stokers in boiler rooms is a pertinent illustration. There are others equally to the point. Furthermore there is a distinct movement, much more marked at the present time in Europe than in the United States, to the location of manufactories and their work people in so-called "garden cities." That is, to establish factories in the country, where land is comparatively cheap, use space freely for the housing of the work people as well as for the productive activities, and make the surroundings as attractive as may be. Doubtless this movement will continue to grow until, a better system of industrial economics having been generally accepted, the congested factory district of the large city will be less in evidence than now. In the meantime it is worth while to make the best of present conditions.

In every place, even in a factory, there are men and women who give a touch of their own personality to the little corner in which they may happen to work. If, fortunately, the person in charge of the work room be of such a nature, the whole shop takes on an atmosphere that markedly differentiates it from the others in the factory. Very likely no great change is made, no large thing done. Quite likely none of the employer's money is spent. But somehow the place looks different; it has an individuality that others lack. Perhaps it is only more neat and tidy; possibly a little picture, more than likely without a frame, lends a touch of color or repose to the walls; may be it is a pot or box of plants in bloom in the window. The place will be fairly radiant with cheerfulness, and everybody will want to sing or whistle at his

"FIELD DAY"—TYPICAL OF AN INSTITUTION FOUND IN MANY FACTORIES.
The view shows athletic sports of the Ludlow Manufacturing Associates.

ATHLETICS ON AN EMPLOYEES' PICNIC DAY.

Acme White Lead & Oil Co., Detroit, Mich.

work. And why should not people sing and whistle at their work? It is one of the surest evidences we have of cheerfulness and happiness; and if outward surroundings or internal exhilaration makes a man want to express his joy in music and work, what good reason exists for repressing one of the two modes of expression? Men ought to want to sing at their work, and they would, if happy and free to do so. But the depressing influence of average shop conditions is enough to drown the poesy and joy in almost any nature. It is a satisfaction to reflect that there are very few shops indeed that cannot be made tolerably attractive and pleasant, if the proper effort be but made. Nor is it necessary for the shop owner to go to large expense. A very little encouragement of the interested ones, and a little more example set by the management, will go a long way toward making work rooms pleasant.

One thing more remains to be considered in connection with proper working conditions in all places where women are employed, namely, the supervision of female workers by women. The frightfully immoral conditions that have existed, and unfortunately are not yet so rare as they should be, in work places where both sexes work together, are in large measure the result of placing young girls at work among men without throwing around them any sort of protection or affording them opportunity even to talk in confidence with an experienced woman competent to give sound advice. In departments where the

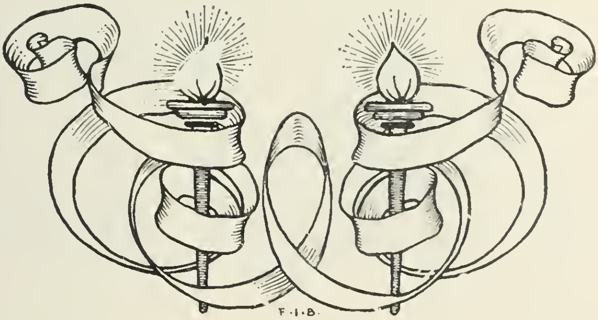
THE DANCING PAVILION ON "DIVIDEND DAY."
Factories of the Procter & Gamble Co., Ivorydale, Ohio.

workers are all women there would seem to be no legitimate reason why competent women could not be found to direct the workers. It is not essential that such a forewoman have charge of men workers, or even that she be independent of a general foreman. Indeed, it is found that a female assistant to the foreman, charged with the supervision

BILLIARD ROOM FOR EMPLOYEES.

Club House, McCormick Works of the International Harvester Co., Chicago.

of the girls, is a satisfactory arrangement. A woman supervisor or matron, not charged with responsibility for production, but to whom a group of girls, possibly the whole feminine working force, is responsible in things not immediately concerning their work, takes the place of the forewoman in some factories. In some instances such an arrangement is even better than the former, particularly if it be impracticable to have both a matron and a forewoman. The mere presence of a woman of broad sympathies and strong character among the women of an industrial or commercial establishment is enough to create and maintain an atmosphere of decency. Her usefulness will, however, in large measure depend upon the extent to which the management will co-operate with her in eliminating undesirable characters and the preservation of conditions conducive to decency and modesty.



SPEED CHARACTERISTICS AND THE CONTROL OF ELECTRIC MOTORS.

By Charles F. Scott.

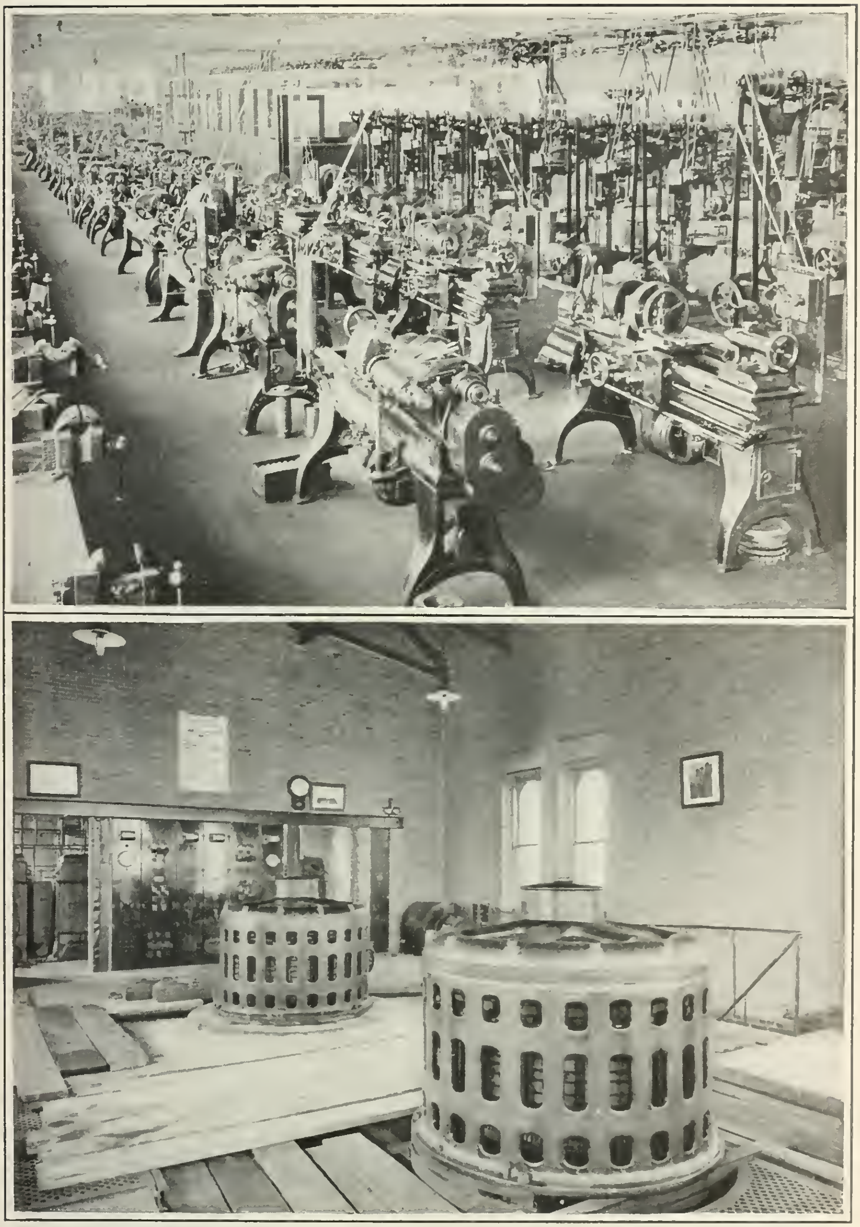
Mr. Scott, as President of the American Institute of Electrical Engineers, as well as by his professional work, has achieved an international reputation. In this paper and a second one, to follow next month, he gives a plain, practical synopsis of the various methods of speed variation for electric motors, adapted to put the subject at the complete command of the engineer interested in the use or operation of electric-driven machinery; and thus he shows how to widen the range of electric-power uses.—THE EDITORS.

ONE evening a few years ago I visited one of the largest steel mills in Pittsburg. A great ladle holding fifty tons of molten steel was lifted and carried quietly and quickly some little distance, and was then adjusted for pouring the steel into ingots. There were but few men in sight, and they seemed to have no connection with the moving mass of white-hot metal. Amid the occasional flaming of furnaces and the deep shadows of the weird scene, I discovered a man in a cage at one end of a high crane who was operating some levers. A few minutes later, in passing from one building to another, it was necessary to stand aside while a number of laborers passed, each carrying an ordinary plank. Each of these men was working harder in transporting a board than the operator of the crane in manipulating his ladle of steel.

It requires incidents such as this to make us realize what remarkable things the electric motor is doing, as its ordinary performances are becoming quite commonplace.

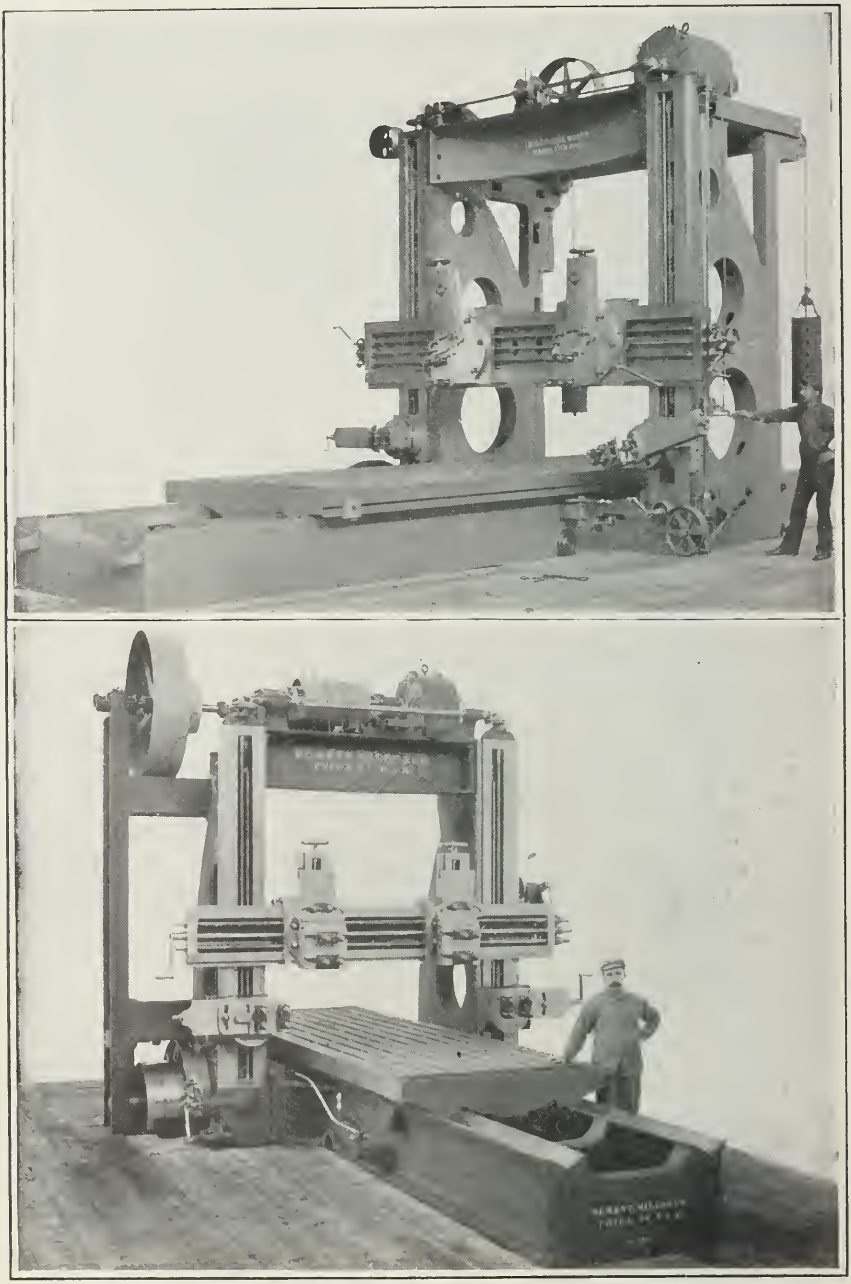
The application of electricity producs two kinds of types of effects. In the first place, the same results which were accomplished by former methods may often be secured at a reduced cost and with greater convenience. For example, the power from an engine may be transmitted to a large number of small sections of shafting in an extensive factory more readily by a system of dynamos, wires, and motors, than by belts and long shafting. The same engine in both cases may drive the same tools at the same speed.

In the second place, new results may be secured through the use of electricity. In fact as a general result, its introduction leads to new methods which secure a greater output and increased excellence. The introduction of the motor into the machine shop has resulted in new



RECENT INSTALLATIONS OF ELECTRICALLY OPERATED MACHINERY.

The upper view shows lathes in the West Lynn Works of the General Electric Company—an illustration of the fine illumination, compactness, and neatness of this mode of operation. The lower shows vertical-shaft induction motors driving 12,000,000 gallon centrifugal pumps. Rotterdam station, Schenectady water works. General Electric Company's motors.

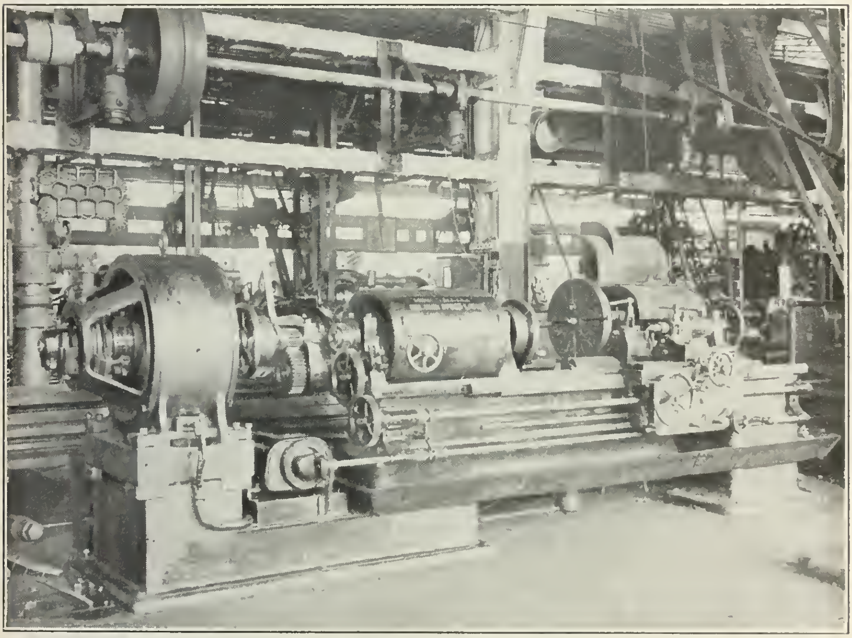


TWO EXAMPLES OF HEAVY PLANERS, ELECTRICALLY DRIVEN.

The upper one is made by the Niles-Bement-Pond Co.; the lower by Bement, Miles & Co. Both are operated by Westinghouse motors.

methods of applying power and controlling it, which have not only increased the output of the tool but have reacted upon its design so that new methods have been worked out, leading to radical advances.

As long as the reasons for adopting electric transmission in factories were limited to improvements in the transmission system it did not have a very attractive future. The total cost of supplying power in many large factories is but a small per cent of the total cost of manufacture. It was difficult, therefore, for the electric motor to make much headway when its field was limited to reductions in the cost of an item which was but four or five per cent of the total. On the other hand, when it was appreciated that the motor, by means of its speed adjustment and other characteristics, could increase output, improve products, and materially reduce labor cost, then the real usefulness of the motor was recognized. The motor is useful not because it reduces power demands, but because it enables greater power to be used effectively.

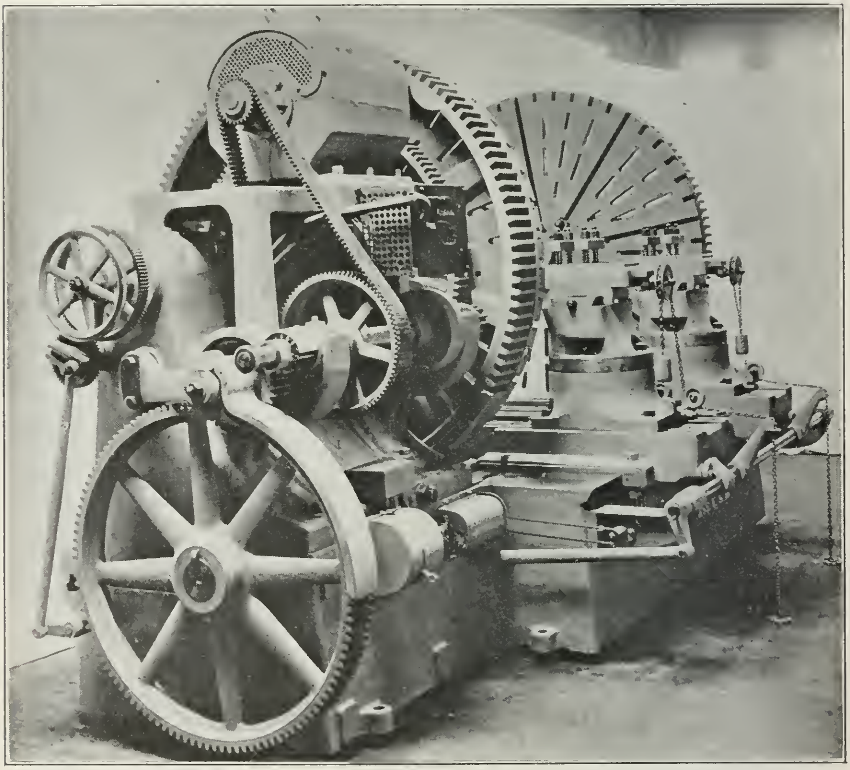


AN EXAMPLE OF MACHINE-TOOL PRACTICE AS MODIFIED BY ELECTRIC POWER APPLICATIONS.

Lodge & Shipley high-speed lathe driven by Westinghouse electric motor.

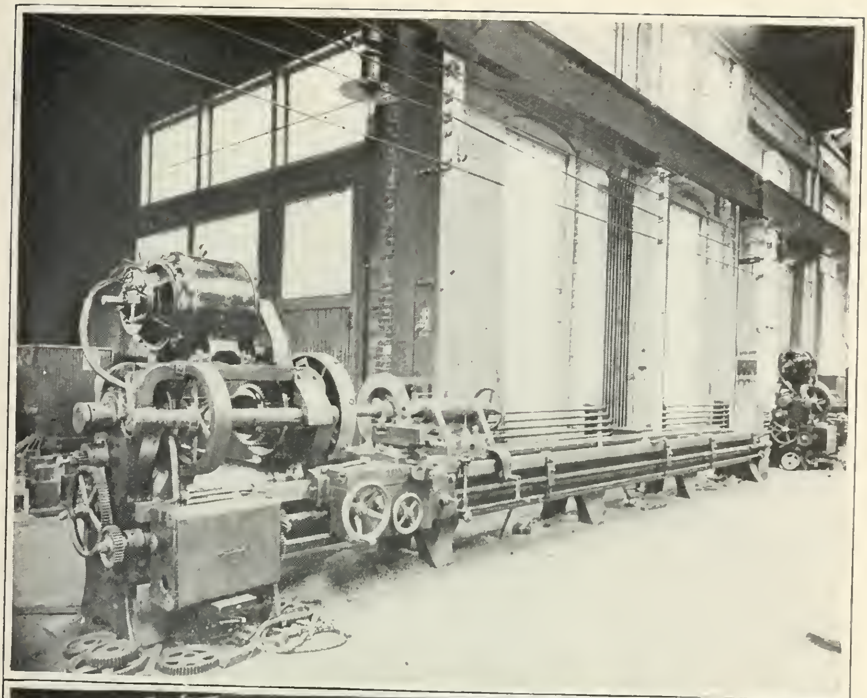
The rapidity of the changes which have taken place in machine-shop practice, most of which are closely associated with the electric motor, is one of the striking features in recent mechanical and electrical development.

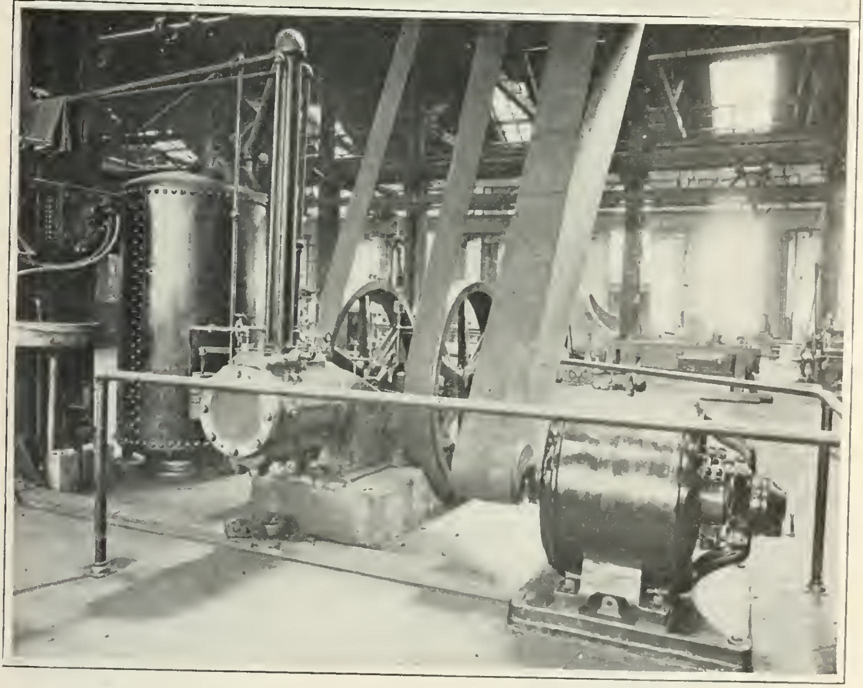
It is interesting to note that one of the principal features which makes the motor useful and successful is mechanical rather than electrical. This feature is speed control. The control of the application of power by which the speed may be varied is the problem involved. Mechanical devices have been found wanting. There is no simple, universal, mechanical method of efficiently and satisfactorily varying the speed. If a mechanical engineer desires to make speed changes other than the most simple kind, he is pretty sure to leave his own field and seek the solution of his problem in the electric motor.



PUTNAM LATHE DRIVEN THROUGH SILENT CHAIN BY GENERAL ELECTRIC MOTOR.
Twenty-five-horse-power direct-current. Speed variable from 350 to 1,050 revolutions.

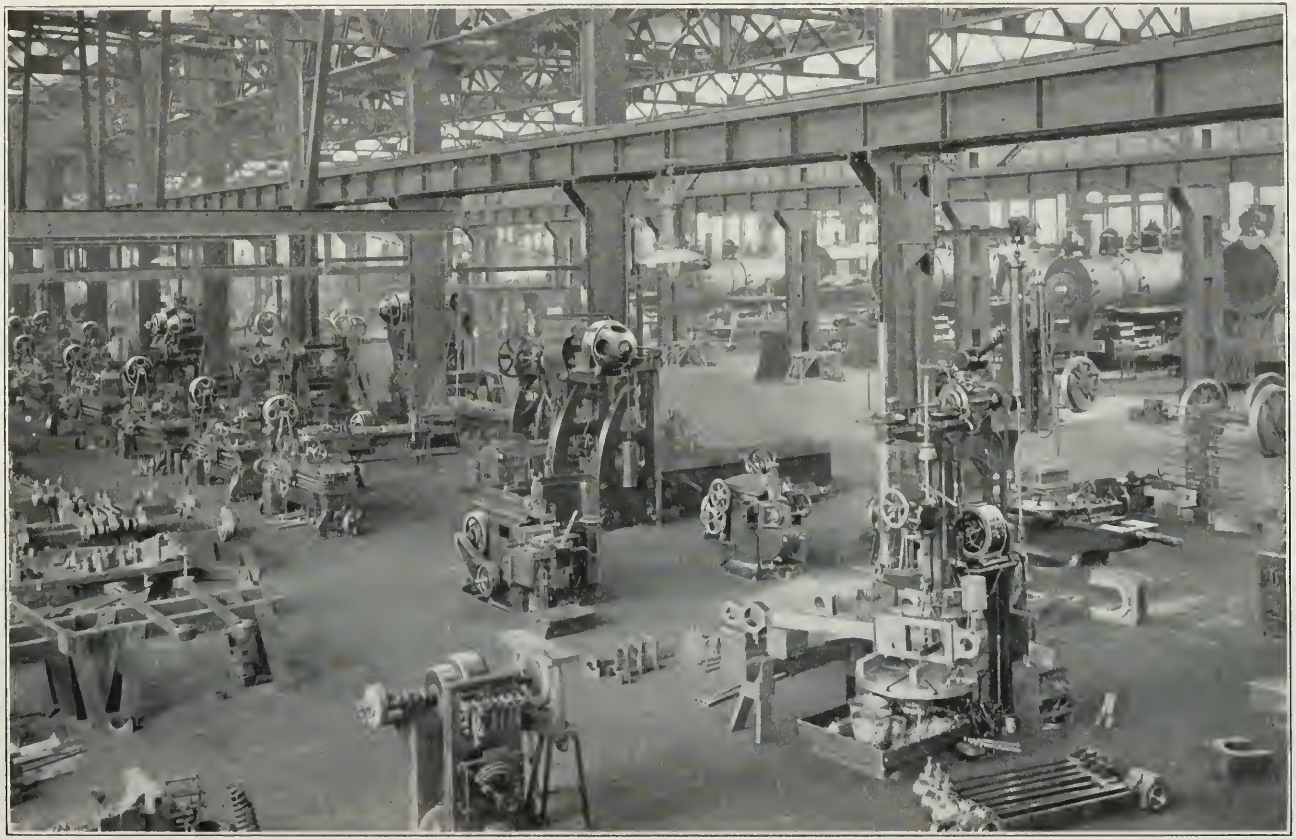
It is, therefore, the speed variation of the electric motor which is one of its most unique and important characteristics. It is the purpose of this paper to consider the speed characteristics of motors in general, and of several types in particular. From this the applicability of different types of motors to different kinds of service will be determined.





EXAMPLES OF MODERN ELECTRIC-MOTOR-DRIVEN MACHINE INSTALLATIONS.

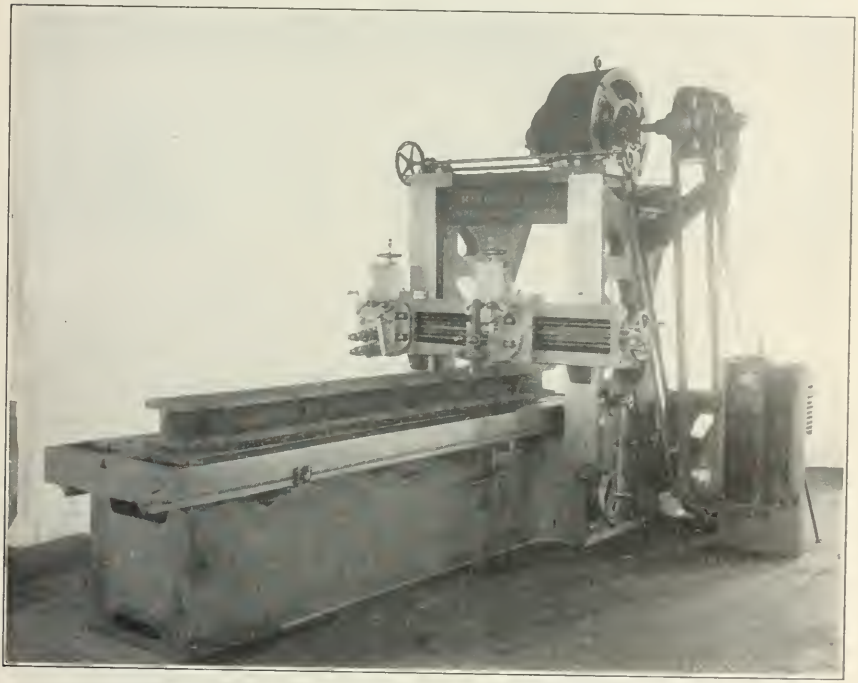
The upper view shows lathes, and the lower an Ingersoll-Sergeant air compressor, all driven by Allis-Chalmers motors, in the shops of the Hooven, Owens, Rentschler Co., Hamilton, Ohio.



INDIVIDUAL-MOTOR INSTALLATION FOR ELECTRIC DRIVING OF MACHINE TOOLS, PITTSBURG & LAKE ERIE RAILROAD SHOPS.

Crocker-Wheeler motors, with multiple-voltage speed control.

The two factors which determine the rate at which work is being done are force and speed. Different designations are convenient for motors with rotating armatures—torque, or the force in pounds at one foot radius, (which is equal to the pull on a belt running on a pulley two feet in diameter), and speed in revolutions per minute. The mechanical performance of a motor is determined by these two elements, torque and speed. Its characteristics and its suitability for specific uses are dependent upon the relation between speed and torque.



WHITCOMB PLANER DRIVEN BY WESTINGHOUSE MOTOR.

A motor may run at constant speed with varying torque. Changes in load within the proper limits of capacity do not change the speed.

A motor may run at constant torque with varying speed. Such a motor geared to a pump would enable it to develop a constant pressure with varying volume, the latter varying with the speed.

A motor may develop different torques at different speeds. A familiar example is the railway motor, which runs slower up a grade where greater torque is required than is necessary on level track.

The interrelation of speed and torque may be shown on speed-torque curves. Several typical curves will be referred to in connection with the motors to which they apply.

WESTINGHOUSE MOTOR DRIVING CONCRETE MIXER AT THE EDGAR THOMSON STEEL WORKS.

It will be useful to consider in a more or less elementary way the electrical characteristics of motors upon which their speed-torque curves depend. Direct-current motors will be taken up first, after which several types of alternating-current motors will be discussed.

Direct-Current Motors.

A direct-current motor has two elements, a field and an armature. The field poles are surrounded by coils of wire. Current through these coils produces a magnetic field which passes through the armature. The armature rotating in the magnetic field has a pressure or electromotive force generated in it which may be measured at the brushes which rest on the commutator. This electromotive force is proportional to the field strength and to the speed. When the motor is connected with a supply circuit the speed will so adjust itself that the electromotive force produced in the armature corresponds to that of the supply circuit.

The speed of a motor depends upon:

(1) The field strength of the motor.

(2) The electromotive force, or voltage, applied to the armature.

A constant speed results, therefore, if the field strength and the voltage are constant, although the load may vary. A constant speed will likewise be secured if any decrease in either element is accompanied by a corresponding increase in the other.

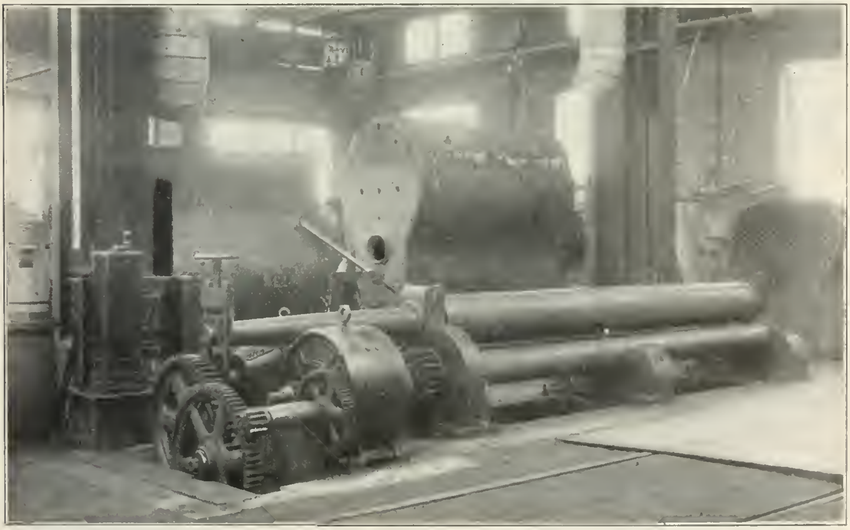
A variable speed results from the variation of either element alone, or of both, provided the increase of one is not accompanied by a corresponding decrease in the second.

Variable speed is obtained in some cases by independent adjustment, in other cases automatically by the effect of change in load.

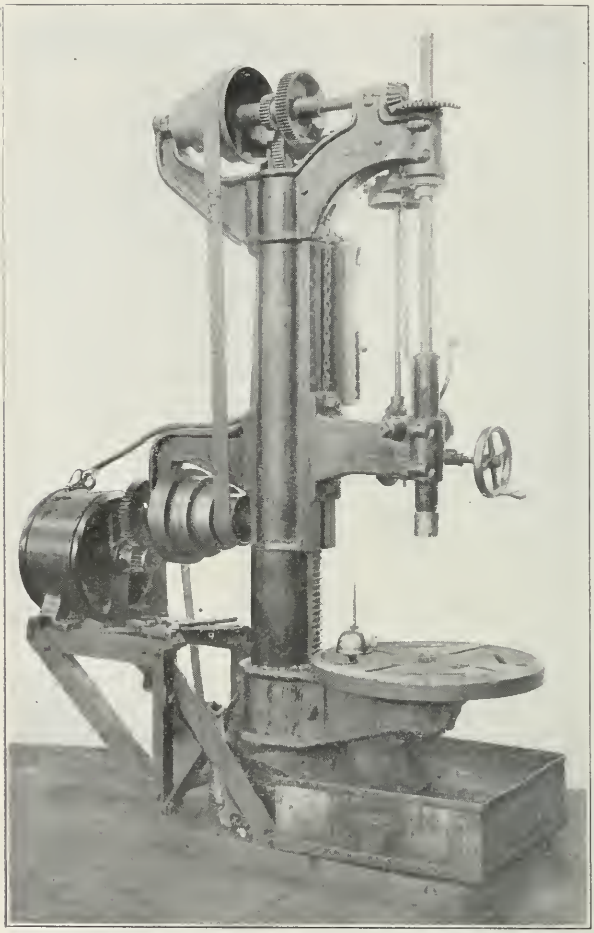
I. Speed Control by Field Strength.—There are several methods of varying the field strength, those commonly used being exemplified by the shunt, the compound, and the series motors.

(a) The shunt motor has its field winding connected to a constant-voltage supply circuit. Its current is therefore independent of the current to the commutator, as the two are connected in parallel. The speed is therefore independent of the load; the motor is inherently a constant-speed motor and changes must be effected by external means. The insertion of an adjustable resistance in series with the field circuit is a ready means of making such changes. The resistance reduces the current; this in turn reduces the strength of the magnetic field and an increase of speed results. If speed is to be adjustable, either above or below a certain normal, the motor is so designed that there is some resistance in the rheostat at normal speed, thus allowing for either increase or decrease.

If the field current at its new value remains constant, the motor has a new speed which it maintains independent of the load. This is quite an important matter. Although motors which are adjustable



ELECTRICALLY DRIVEN BENDING ROLLS, UNION PACIFIC RAILWAY SHOPS, OMAHA, NEB.
Niles machine and Westinghouse motor.

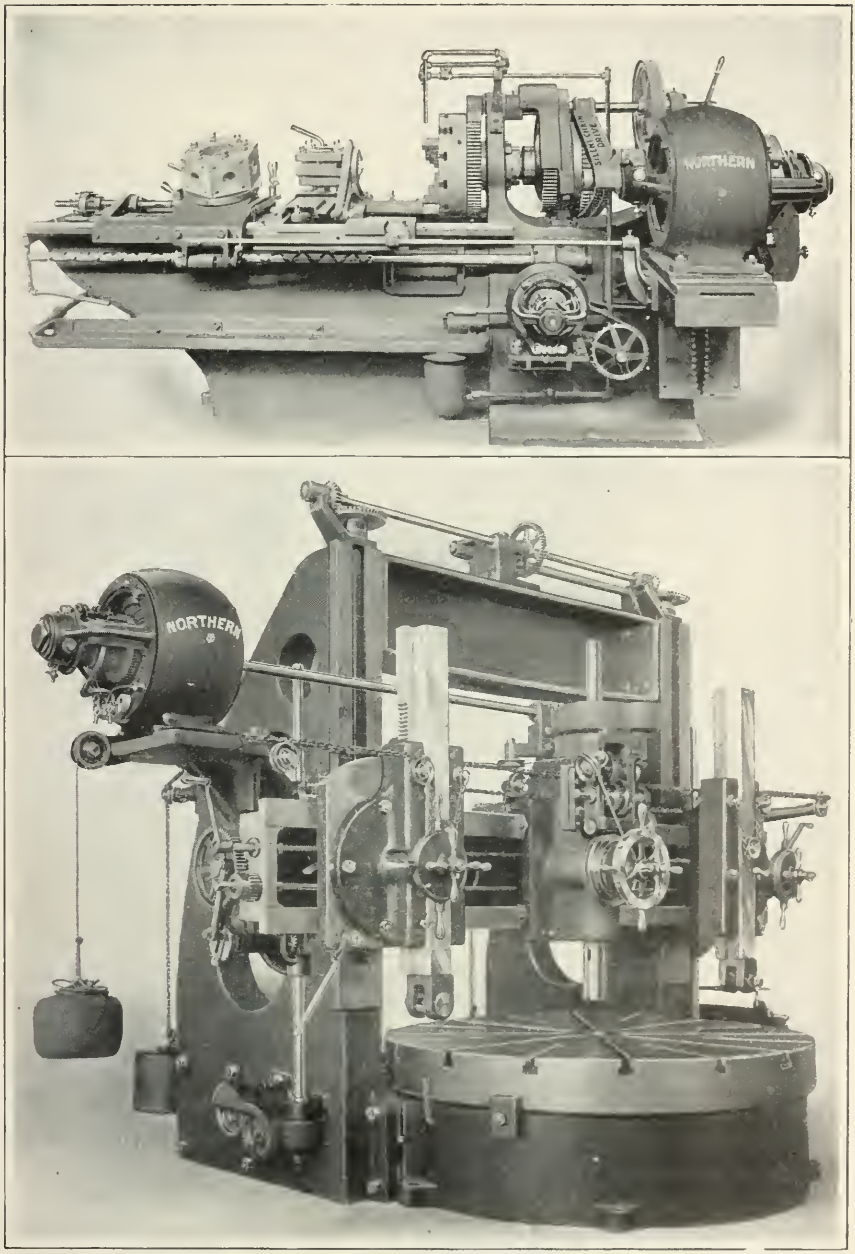


RADIAL DRILL OPERATED BY ALLIS-CHALMERS MOTOR.

in this manner for running at different speeds are in a general way termed "variable-speed" motors, they are really *adjustable-speed* motors, as they maintain with varying load the constant speed for which their rheostats are adjusted.

The practical limits of speed variation by this method of control depend upon the characteristics of the motor to which it is aplied. It is rarely that a motor may not be varied over 5 per cent or 10 per cent, and motors may be designed for an increase of 100 per cent and even of 300 per cent of the minimum speed. Motors which have a wide variation are heavier than a motor designed for a single speed only. Some of the relations between capacity and speed variation will be taken up later on.

(b) The compound motor has two independent field windings. One is the shunt winding, which is connected to the circuit in a similar manner to the field winding of the simple shunt motor. The other is the series winding which carries the armature current. When there is no load the series winding is inactive; when there is load, the current passing to the armature through the series field is effective in proportion to the load. The current in the series field may pass



MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The top figure is a Gisholt turret lathe, with 5-horse-power Northern single-voltage variable-speed motor driving the spindle through silent chain, and small motor driving pump and turret mechanism. The lower one is a boring and turning mill, by the Betts Machine Co., Wilmington, Del., with 5-horse-power Northern motor (340-1,350 revolutions) driving the grinding spindle. Northern Electrical Mfg. Co.

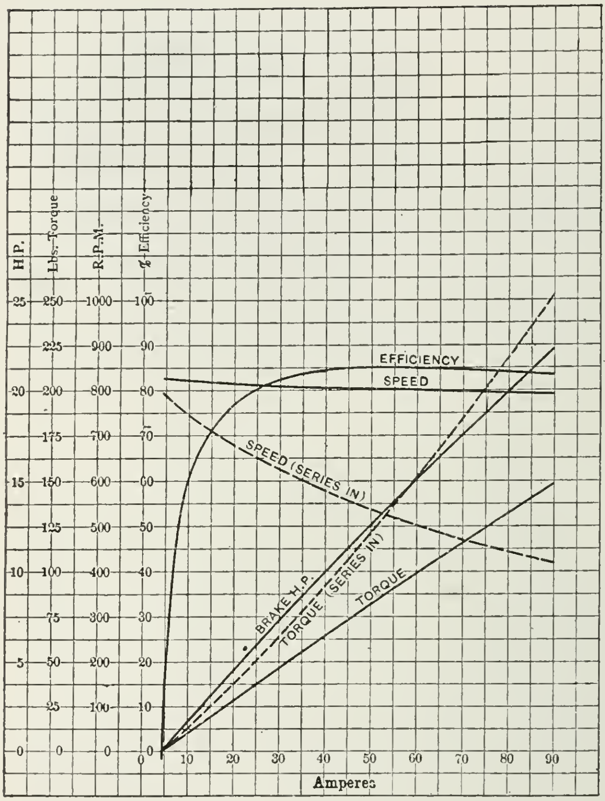


FIG. I. TYPICAL CURVES FOR SHUNT AND COMPOUND MOTORS.

around the field poles in the same direction as the shunt current, or it may oppose it. In one case the field is strengthened and the speed becomes less; in the other the field is weakened and the speed becomes greater. Compound motors have a no-load speed which is fixed by the value of the shunt field current, and the speed is usually made to fall off from the no-load speed in approximate proportion to the load. The motor therefore becomes inherently a slower speed motor as the load is increased, or, stating it in a slightly different way, the motor runs at light load at a higher speed than at full load.

Typical curves for a shunt and a compound motor are shown in Figure 1. The curves representing the two types are taken from tests upon the same motor, first with the shunt winding only and then with the shunt and series windings both active.

The horizontal scale is plotted in amperes. The speed, torque and brake horse power corresponding to any given current may be found on the vertical line corresponding to that current. The heavy lines representing the performance of the shunt motor show that the torque and brake horse power are closely proportional to the armature current. These curves, however, strike the base line at approximately 4 amperes, this being the constant current in the shunt field. The speed is approximately constant at about 800 revolutions per minute, falling slightly, however, with load. When the series coil is in commission the increased field strength causes the speed to fall off rapidly. The torque is correspondingly increased so that the brake horse power corresponding to a given current is very nearly the same as it is when the motor is running as a shunt motor. The very considerable increased torque at low speed is serviceable in those cases where large torque is required for starting and for accelerating, as, for example, in elevator service. When the motor has attained speed the series winding may be kept in circuit, or it may be cut out of circuit and the motor may run as a shunt motor.

(c) The series motor has its field winding connected in series with the armature. The current in its field varies directly with the current in the armature, and, therefore, increases with the load. If the load be lessened the current is reduced, the field strength is likewise reduced, and the speed increases. If the load be made very small the speed may become so high as to endanger the armature mechanically. It is therefore inadvisable to use the series motors if the load is liable to be very small. A compound motor with a strong series winding has nearly the same characteristics under load and has the safeguard of a definite maximum-speed limit. The series motor is

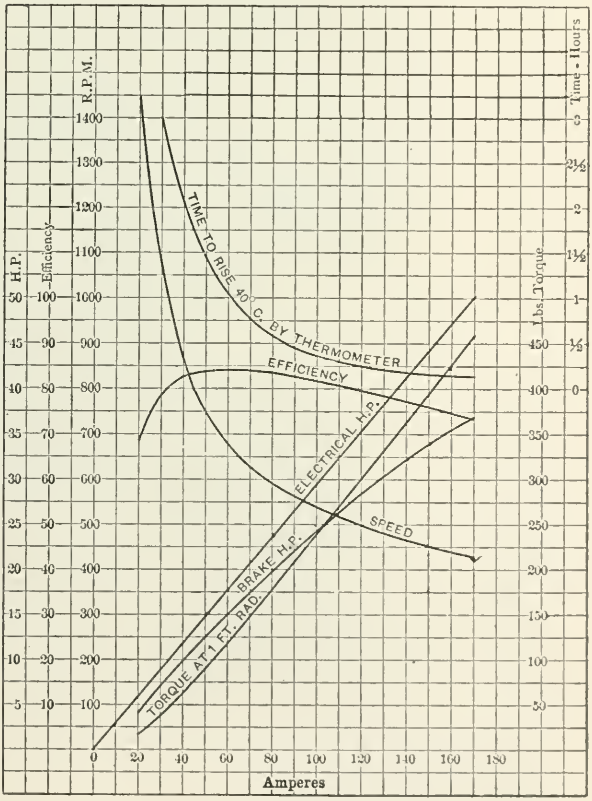
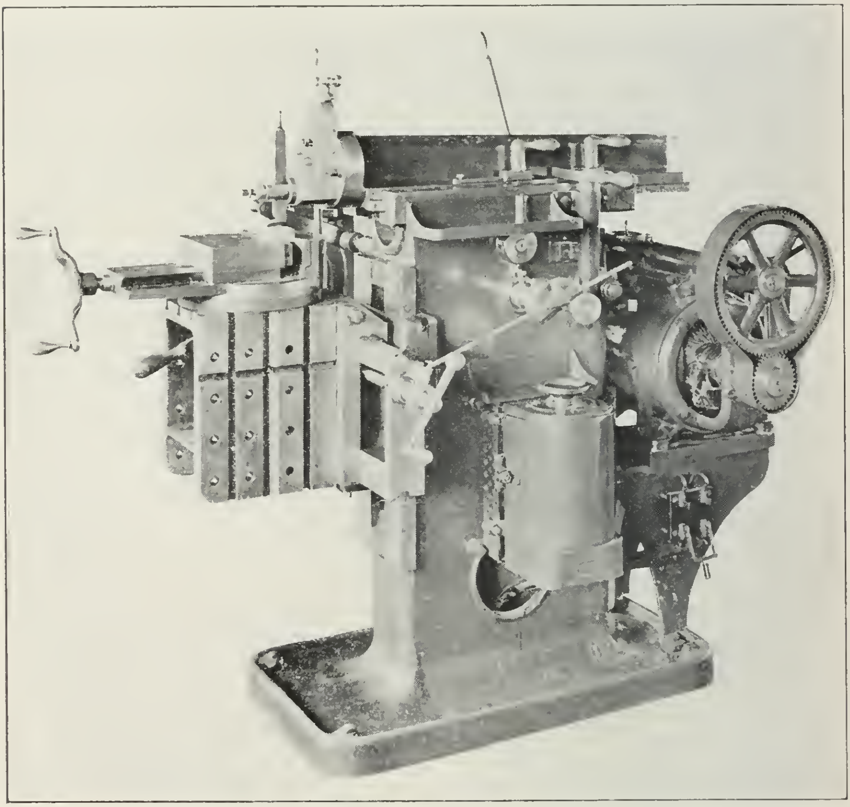


FIG. 2. CHARACTERISTIC CURVE FOR SERIES MOTOR.

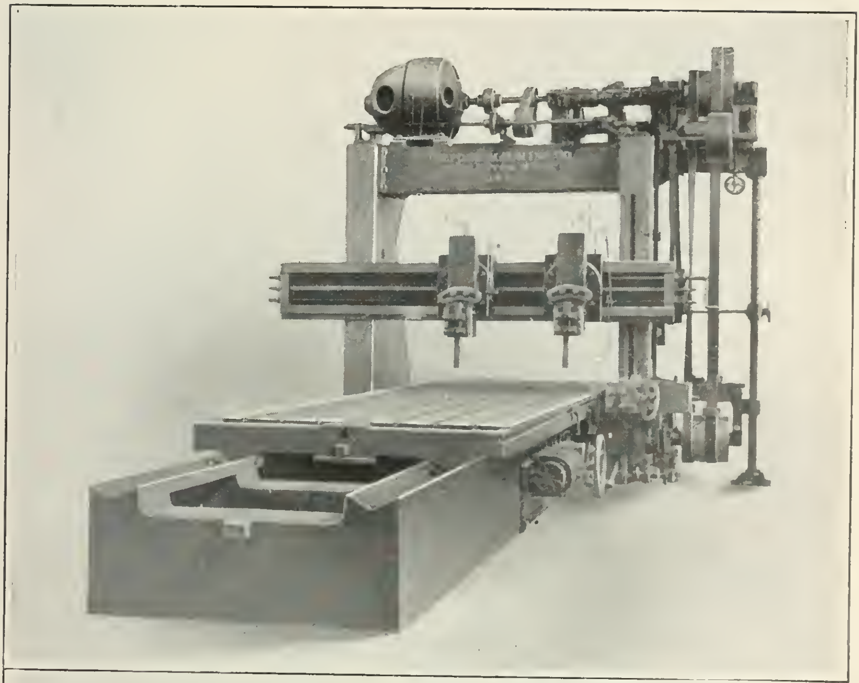
used on street cars and locomotives and for cranes and hoists, where the motors are under the control of an operator.

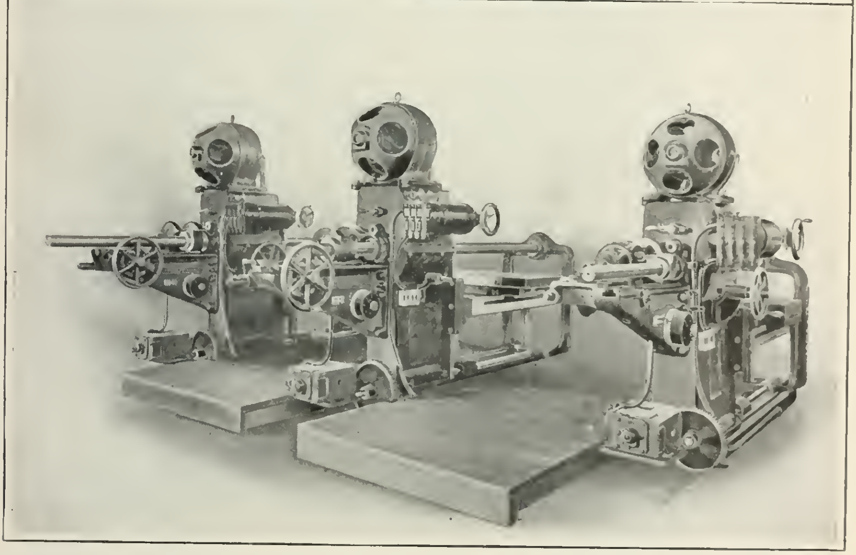
A characteristic curve for a series motor is given in Figure 2. The speed curve except at light load is approximately similar to that of the compound-wound motor. At light load when the current is relatively small, the speed, however, increases very considerably. The torque and brake horse power both increase as the current increases. The torque has an increasing rate while the brake horse power increases less rapidly than the current due to losses in the motor. If it were not for these losses the electrical horse power would increase in proportion to the current. The straight line representing the electrical horse power input shows that the power taken is proportional to the current, and the falling off in the output is therefore the result of the decreasing efficiency at greater loads.



GENERAL ELECTRIC MOTOR DRIVING A HENDY SHAPER.
Direct-current, one-horse-power, 500 to 1,500 revolutions.

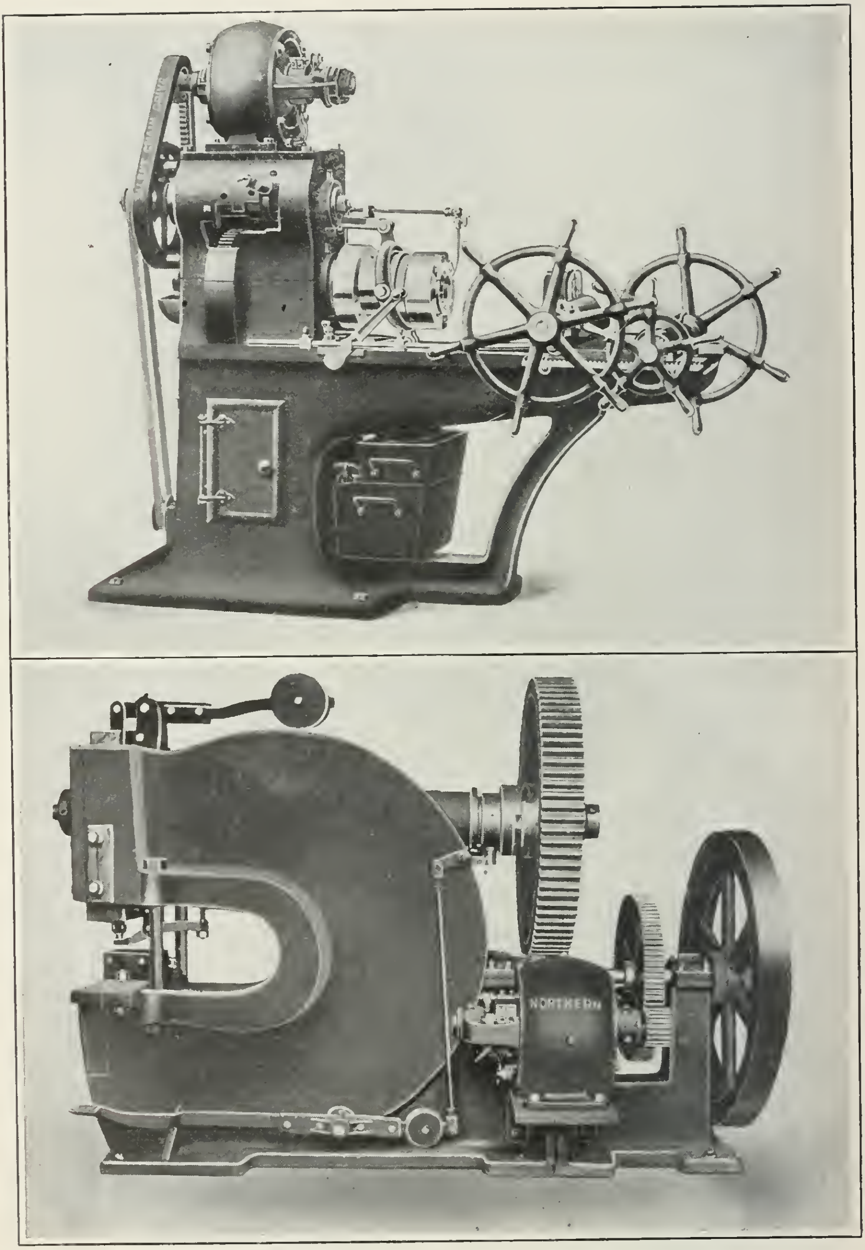
II. Speed Control by Armature Voltage.—The speed of a motor





MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The upper illustration shows a planer by the L. W. Pond Machine Co., and the lower a group of horizontal boring and drilling machines by Bement, Miles & Co., all equipped with Crocker-Wheeler motors with multiple-voltage speed control.

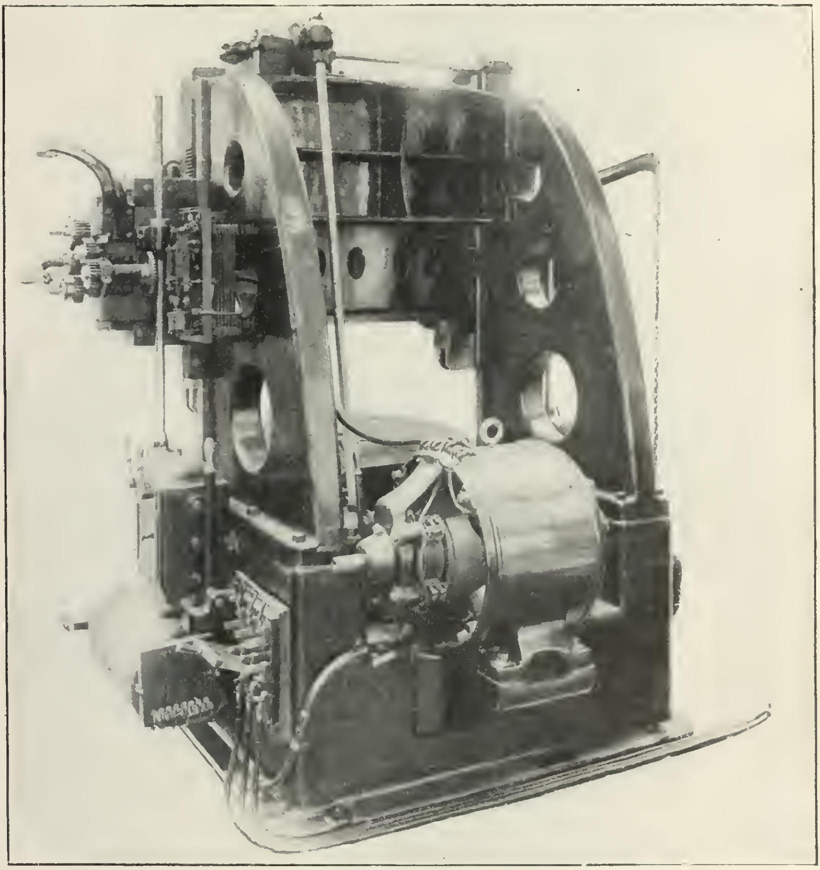


MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The upper figure shows a threading and cutting-off machine, by the National Machinery Co., Tiffin, Ohio, with Northern single-voltage variable-speed motor; the lower is a punch, by the Cincinnati Punch & Shear Co., with 7½-horse-power Northern spherical motor.

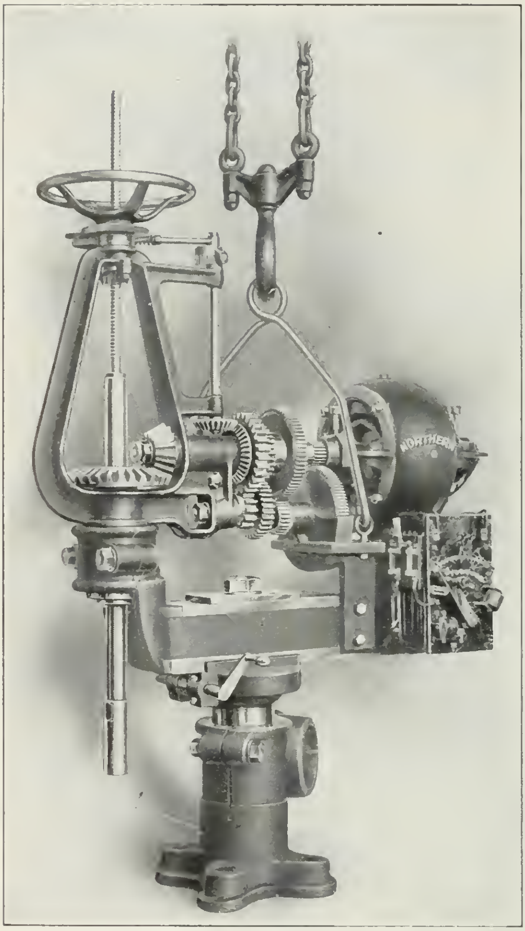
depends upon the electromotive force or voltage applied to its armature. There are several methods of varying the voltage applied to the armature. Some of these methods involve only the motor and its auxiliary apparatus, while others require special supply circuits.

(a) Control by armature resistance is a simple and convenient method. The resistance is placed in series with the armature circuit. The current suffers a loss of voltage in passing through the resistance.



KING BORING MILL DRIVEN BY ALLIS-CHALMERS MOTOR.

It follows, therefore, that the voltage delivered at the armature terminals is reduced by an amount dependent upon the value of the resistance and the quantity of current flowing. This method of control is commonly used for starting motors of all classes. If the motor were connected directly with the circuit for starting, the initial current would, in general, be very large. It is therefore suitably reduced by the resistance which is reduced step by step and is cut out entirely



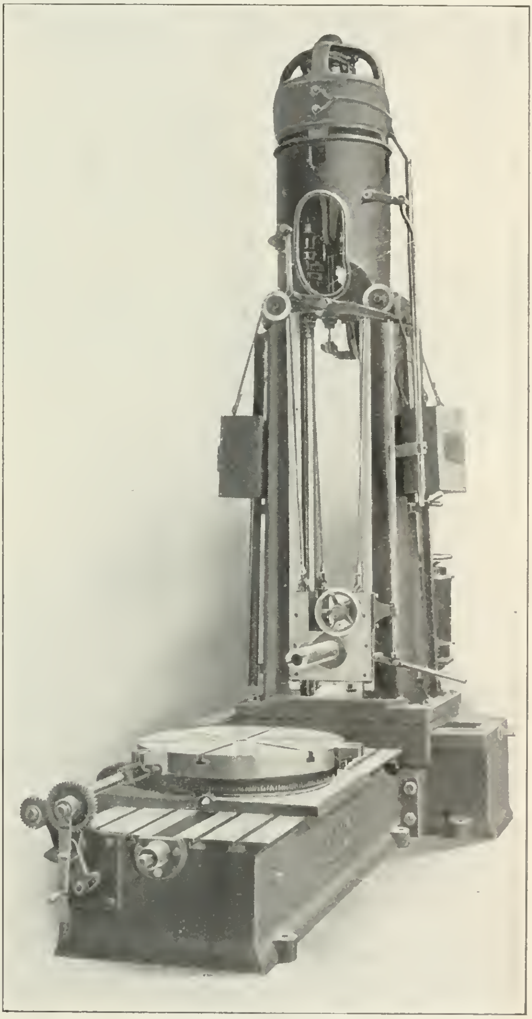
ELECTRIC DRIVING OF A PORTABLE TOOL.
Northern Electrical Mfg. Co.'s spherical motor applied to portable drill built by Thos. R. Dallett & Co., Philadelphia.

when the normal conditions of operation are reached.

As a shunt motor has its shunt field connected directly across the circuit, the field strength is independent of the armature resistance and armature current. If the field strength be kept constant the speed will, of course, be proportional to the armature voltage. The insertion of a given resistance in series with the armature will reduce the voltage on the armature by an amount dependent upon the strength of the current, and if with a certain load the reduction in voltage and in speed be, say 10 per cent, then an increase in the load which doubles the current will cause a reduction in voltage and in speed of 20 per cent. This example illustrates the character and principal limitation of this method of speed control—namely, that the speed varies with the load. This method is, therefore, quite unsuited to those applications where constancy of speed under varying load is essential. The loss of power in the resistance is likewise an objection to this method of control. The power which is delivered by the current passing through the resistance and armature divides in proportion to the electromotive forces. Thus, if the resistance absorbs 10 per cent of the electromotive force, it likewise absorbs 10 per cent of the energy, and the power delivered to the armature is 90 per cent. In general, the proportion of power delivered to the armature is in proportion to its speed. If the speed be reduced by the resistance to 70 per cent, the power received by the armature is 70 per cent.

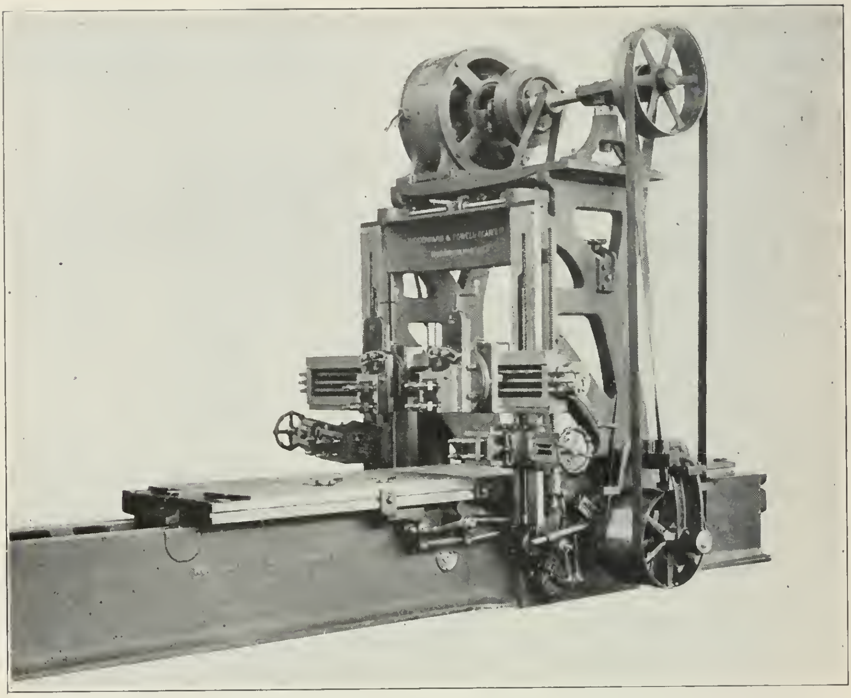
Summarizing briefly the characteristics of this method of control as applied to shunt motors, the favorable points are low cost of apparatus, simplicity, applicability to standard motors, and wide range of speed variation; while the unfavorable points are low efficiency and the resulting higher cost of operation, unstable speed under varying conditions of load, and reduction of motor output at low speeds. There are, however, conditions under which the unfavorable characteristics have but little weight and in which the method may be advantageously employed. It may, for instance, be used in connection with a more efficient system of speed control to obtain lower speeds than could otherwise be secured, particularly if the service at these low speeds is intermittent.

(b) A variable voltage may be obtained from a special generator. In this case the generator may be conveniently driven by means of a motor and the voltage of the gen-



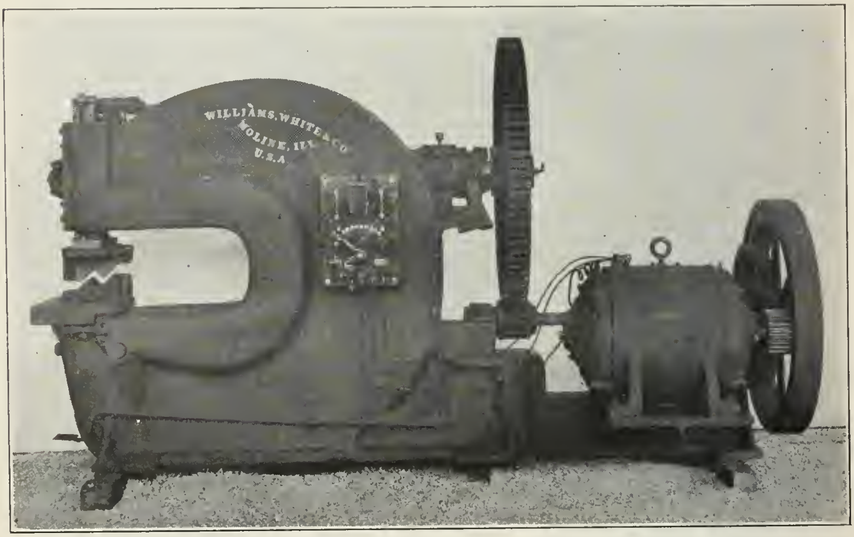
A SPECIAL ADAPTATION OF ELECTRIC DRIVING FOR A MACHINE TOOL.

Newton vertical milling and drilling machine with Crocker-Wheeler vertical motor; multiple-voltage speed control.



A RECENT ELECTRICALLY EQUIPPED LATHE.

Woodward & Powell machine, Westinghouse motor; 15-horse-power, direct-current, 575 to 1,150 revolutions; cutting speed of table 16 to 32 ft. per minute; return speed 3 to 1.



A LARGE SHEAR AND PUNCH DRIVEN BY WESTINGHOUSE MOTOR.

erator may be varied by a rheostat in its field circuit. This affords a means of supplying an adjustable definite voltage to the motor, which is practically independent of the current taken. In so far as the motor is concerned, the method is admirable. The objections to it lie in the inconvenience and cost of the motor-generator. It is, therefore, not suited for general adoption, although there are cases in which its advantages overcome the objectional features.

(c) The three-wire system, which, as commonly applied, has 220 volts between two of its wires and 110 volts between each of these and the middle wire. A motor may receive its armature current at either 220 volts or at 110 volts, the speed under the latter conditions being reduced to one-half. Two speeds, therefore, may be obtained in the ratio of 2:1, without the use of resistances and under conditions in which the voltage applied to the armature does not vary with the load. This method of control may be advantageously combined with control by variation of the field current of shunt motors. If the motor be so designed that it can operate from maximum speed to half-speed when running on 220 volts, it will when connected to a 110-volt circuit operate satisfactorily from one-half to one-fourth speed, thus giving a wide range of speed adjustment. A motor may be designed which may be controlled by its field strength over a wide range in speed, but its size and cost will exceed those of a motor having a range which is only half as great. The latter smaller motor may be given the greater range in speed if it has available the auxiliary half voltage which the three-wire system affords.

(d) A three-wire system with unequal voltages, for example, 80, 160 and 240 volts, affords somewhat greater flexibility in speed adjustment, in so far as the motor itself is concerned. The gain in having the maximum voltage divided into thirds, instead of halves, is not, however, a radical one, and some disadvantages are involved. The dynamos for generating the several voltages cannot be so conveniently arranged as those for two voltages. The amount of current to be delivered to the motor at one-third of the full voltage is greater for the development of a given power at low speed than that required at half voltage. The heavier current may be objectionable both on account of the increased size of conductor necessary between the generator and the motor, and also on account of the greater current which must be handled by the motor itself.

An additional number of voltages may be available by adopting the four-wire system, which will afford additional voltages between the several pairs of wires. This, however, involves greater complication in the generating apparatus and transmission circuits and in the controller. It involves the use of larger currents at very slow speeds than is necessary in the three-wire system. The principal advantage in the use of a multi-voltage system, involving a considerable number of voltages, is that less range of speed is necessary in the field control.

(e) The double commutator motor is a further method of securing speed control. A motor may be provided with two windings and two commutators. The two windings may be identical, and each may be independently connected to the supply circuit; or the two commutators may be connected in series. In the latter case each commutator receives half of the circuit voltage and the speed, therefore, falls to one-half. This method is, in effect, quite similar to the operation of the ordinary motor on the three-wire system, whereby the armature may be supplied with either the full voltage or half voltage. Intermitttent speeds on the double-commutator motors may be obtained by control of the shunt field. The two armature windings, instead of being made equal, may be wound differently. One winding alone may give a certain speed, and the other above a lower speed, or the two windings may be connected in series either in opposition to give a maximum speed, or in the same direction for giving a minimum speed. Intermediate speeds may be obtained by variation of the shunt field current. This system secures a wide range of speed variation. It has, however, certain drawbacks in the complicated construction of both the motor and the controller. The double commutator motor is unusual and of special construction.

A comparison of the foregoing methods of speed control shows several points in favor of control by variation of the strength of the shunt field, when adjustable speeds are desired which shall be constant independent of load variations. The motor and control devices are simple. The supply circuit is of the simplest kind without special generators or additional wires. The current is always a minimum, as no low voltages are used which would require a greater current for a given power.

Speed, Torque, Voltage and Current.—The relations of speed and torque to output and to voltage and current will be apparent upon a consideration of the following relations.

Power is proportional to speed multiplied by torque.

Power is proportional to electromotive force multiplied by current.

If the electromotive force be constant, the speed is constant—therefore, the torque, horse power, and current vary together. If the load be doubled, both the torque and current are doubled. Under these conditions, therefore, torque and current are proportional.

If the electromotive force applied to the armature be varied, the speed changes in a like proportion.

With a definite constant field strength the speed is proportional to the applied electromotive force, and the torque is proportional to the current.

If a motor running at constant voltage carry a load of such a character that the output in horse power is constant at different speeds, then, although the speed may be varied over a wide range, there will be no change in the current, for the reason that both the electromotive force and the output remain constant. Upon this fact depends an important feature in comparing different methods of speed control. If the speed of a motor is to be reduced to one-half, the reduction may be effected as has been pointed out, either by increasing the strength of the field or by reducing the electromotive force applied to the armature. If the speed change is made by changes in the field strength, then the current depends only on the power output and not upon the speed. If, for example, the power required involves a current of 10 amperes at 220 volts for the delivery of a given output, then the current taken from the circuit is the same whether the power be delivered at full-speed or half-speed. If, however, the electromotive force be reduced to half in order to effect the speed reduction, then the current will be doubled, or 20 amperes. The heavier current involves an increased loss in the transmisssion circuits, as well as requiring that a greater current be handled by the commutator and the armature conductors of the motor. It is, therefore, in general, desirable, both on account of the supply circuits and the motor itself, to employ a reasonably high electromotive force, particularly in those cases where the output at low speed may be considerable.

Limitations of Motors.—The characteristics of the motor which fix its limitations in operation form a useful basis for an understanding of the conditions under which it may be used.

(a) Variation of the field strength is a convenient method of speed control, but it has certain definite limitations. The increase in field strength is limited by the physical characteristics of iron and of copper. The iron, which constitutes the magnetic circuit of the motor, has a high permeability, and over a considerable range the magnetic field strength of the motor, varies in proportion to the current in the field coils. As the current is increased, however, the field becomes saturated and the increase in strength is not in proportion to the increase in current. With very heavy currrents a very considerable increase in the field current causes but slight increase in the resulting magnetization. The current passing through the field winding heats the copper conductors. If the current be increased, the heating is likewise increased, but the increase is proportional to the square of the current. Consequently, double current results in four times the heating in the field coils. It will be readily seen, therefore, that as the field current is increased beyond certain limits, the magnetization increases but slightly, although the heating increases with great rapidity. If a motor is intended for operation at constant speed it is usual to proportion the field so that the iron is near saturation and the field coils will operate at a reasonable temperature. On the other hand, if the motor is to operate at a variable speed, to be controlled by the field current, the proportions of the magnetic circuit and the coils are made such as to admit of such an increase in current and magnetization above that required for full speed as may be necessary for operation at the lower speed. The two elements, therefore, which limit the range of field adjustment of a given motor are the saturation of its magnetic circuit and the heating of its field coils.

(b) The electromotive force applied to the armature, which is one of the elements by which speed control may be secured, has a certain maximum limit, depending upon the windings and the commutator design. This limit is usually somewhat above the normal conditions for which the motor is designed. The motor will handle satisfactorily any electromotive force lower than this provided the current is not excessive.

(c) The armature current, and consequently the motor output in horse power under given conditions of field strength and armature voltage, has its limitations in sparking at the commutator and heating of the conductors. The sparking and the general behavior of the commutator depend primarily upon the current strength and also upon the strength of the field. Commutation is much better when the magnetic field of the motor is strong than it is when the field is weak. This is a characteristic which must be taken into account by the designer of the motor. In operation it will generally be found that there is less tendency to sparking with a greater field currrent, consequently a reduced speed secured through increase in field strength enables a greater current to be satisfactorily commutated. On the other hand, a small field current which is incident to a high speed, gives conditions which place the commutation limit at a low value of the armature current. To overcome this limitation small auxiliary field poles may be introduced between the regular poles. The auxiliary poles have windings through which the current from the armature passes. The magnetic field from these poles supplies a local field which facilitates commutation and thereby greatly extends the speed range over which successful commutation can be secured.

The second limitation in armature current is temperature. The heating in the armature conductors is proportional to the square of current flowing. An increase in load, therefore, increases the heating at a rapid rate. An increase of 50 per cent in current more than doubles the heating in the armature conductors. It causes also a like increase in the heat developed in the brushes and brush holders. Heat is developed in the iron core of the armature. This varies with the field strength. With heavy field currents for producing low speeds the heat due to this cause is therefore greater than at high speeds.

The horse-power output of a motor is approximately proportional to the product of electromotive force and current; hence if the voltage be constant and the temperature limits fix the current at a definite number of amperes, then the safe input is independent of the speed and the safe output is the same in horse power at all speeds. This meets the requirement of many machine tools, which use approximately the same power at all speeds. On the other hand, if the method of speed control employed involves the application of different electromotive forces to the armature, the safe horse power output will be less at low voltage, as the allowable current gives less power at the lower voltage.

(d) There is also a mechanical limit to the armature speed above which there is liability to accident.

From the foregoing conditions regarding the limitations of the electric motor, it is seen that the principal limitations in service are commutation and temperature. The temperature limitation is one which is not definite and fixed. If the load be too great for a belt the belt slips; if the load be too great for a water wheel or an engine it slows down or stops. But if a motor be overloaded there will in some cases be a decrease in speed, and in other cases a danger indication at the commutator, but in general it will keep steadily at work, although the temperature may increase considerably. The temperature may rise beyond proper limits, but without giving immediate indication, and, in fact, it is difficult to determine whether the actual temperatures are safe. The effects of high temperature may not manifest themselves at once but may result in a slow charing of the insulation, which may not be detected until the damage has been done. In general, therefore, motors should receive a degree of reasonable intelligent supervision to prevent overloading, which may be unnecessary with other types of apparatus which have more prompt and emphatic methods of indicating when their proper limits are exceeded.

The temperature of a motor which is in continuous service at constant load depends upon the rate at which heat is generated in the motor and the rate at which it is dissipated. If, however, a motor is subjected to intermittent service the operation of heavy loads is an important factor. It is obvious that the motor which could carry 10 horse power continuously might carry considerable greater loads for short intervals without exceeding the same temperature limits. As the variety of load conditions to which a motor may be subjected is infinite, it is impossible on the one hand to lay out any very definite rules covering the variable service of motors. On the other hand, it is rarely the case that the variable conditions are definitely known. The average load upon the crane or machine tool and the proportion of time during an hour or a day during which the load will be heavy depends upon service conditions, which cannot usually be definitely foretold. In the selection of a motor there is liability either of installing a motor which is larger than necesssary or of selecting one which is too small. The capacity of the motor may be specified by the length of time which it requires to rise a given amount in temperature under different conditions of load. Such a safe temperature curve is given in Figure 2, which shows that the motor may run for several hours at a light load before attaining a temperature which would be reached in 10 minutes at heavy load.

In the foregoing considerations regarding motors, general principles have been discussed, and a number of secondary and minor features have not been taken into consideration. For example, the speed of a motor with constant field strength and constant armature voltage is usually not constant, but falls off slightly with load; again the product of electromotive force and current supplied to the armature of motor is not an exact measure of the power developed, on account of the losses between the electrical terminals and the pulley. These vary in different motors, and it would simply lead to confusion to endeavor to consider them fully in a paper of the present general character.

The consideration of alternating-current motors with respect to their speed characteristics and control is reserved for a following paper.

THE BETTERMENT OF POWER-STATION ECONOMY BY ELECTRIC AUXILIARIES.

By Arthur S. Mann.

The importance of the subject of auxiliaries is not always fully appreciated, and too often these necessary adjuncts are neglected, while the greatest care is given to the economical performance of the main engines. Power-house engineers may well consider the experience which has been attained in this matter by marine engineers and by the engineers of the great textile mills, where the final efficiency of the whole plant in money is the only thing which is allowed to count. The practice of drawing steam from the receiver of compound engines for use in heating water has been found advantageous in many cases in factory practice, while in some instances in marine service it has been found economical to have the steam-driven auxiliaries discharge their exhaust steam into the receiver of the main engine, the various auxiliary cylinders thus becoming a part of the high-pressure system of the engine, aiding to do work in its intermediate or low-pressure cylinders.

Mr. Mann here gives some valuable data and results as to the use of electric motors for operating auxiliaries, and there are many locations where the convenience of this system appeals. Each case, however, must be designed according to its own local conditions and the advantages balanced against the losses, not only of steam but of cash. It would be most interesting to study the general question of auxiliary machinery, in the power house, in the mill, and on the ship, and Mr. Mann has here given a view of one portion of this large subject, that of the operation of auxiliaries by electric motors.—The Editors.

THE exhaust steam coming from steam-driven auxiliaries is so valuable for heating feed water that the facts that such apparatus is rather inconvenient, and uses rather more steam than it ought, are condoned. In fact, it is sometimes stated that the more steam such auxiliaries use, the better, for they are really a reducing valve and all they throw away can be well used.

It is obvious that the fact that they do turn into mechanical work a portion of the heat energy in the steam consumed before passing it on to the feed-water heater, is the sole difference between such a system and that of using live steam for heating feed water. Hot feed water is an acknowledged advantage, and that feed-water-heating system is most efficient which makes good use of the largest portion of heat that cannot be used to better advantage elsewhere.

The auxiliary apparatus in an ordinary station of 10,000-kilowatts capacity provided with pumps enough to maintain a 28-inch vacuum, which pumps its own condensing water, handles its coal mechanically, and uses mechanical draft for combustion, will use about 5 per cent of the boiler output. There will be in all about twenty-nine separate pieces of apparatus which must be driven in some way, viz.: two excitors, three circulating pumps, three air pumps, three feed pumps, two oil pumps, four fans for furnaces, two coal and ash conveyors, two coal crushers, six mechanical-stoker systems, and one or more pumps for low-pressure water service—which latter are not in use all the time, perhaps. This number will be varied slightly in different stations, but the list given is typical and the apportionment is within the bounds of sound practice.

These machines will call for 60 horse power in some cases, and 5 horse power may be taken as the lower limit. They will not all be running at one time, but under usual conditions there will be 245 useful horse power developed by such gear, and they will consume 25,500 pounds of steam per hour when valves and pistons are in good average condition. This steam will impart about 150 British thermal units to the feed water of the whole plant, giving a final temperature of 200 degrees from a cold feed of 50 degrees. The auxiliaries must be debited, then, with 25,500 pounds of steam per hour and credited with 245 useful horse power and with 2,700,000 British thermal units imparted to the feed water.

As an alternative to this system there is the possibility of using electric auxiliaries. In such a case there is no exhaust for feed-water heating. But there is something better.

The steam at about atmospheric pressure, either a little above or a little below, within a steam-turbine casing, is admirably suited for this feed-water heating. It has performed its mechanical work, and withdrawing it does not disarrange the performance of the turbine itself except in so far as a certain amount of steam does not pass through all the wheels.

To return to the actual figures already given, the 25,500 pounds of steam per hour will produce about 870 horse power in the turbine before it is reduced to atmospheric pressure. The figures would be reduced somewhat by transformation losses and the motors themselves, but not more than 20 per cent of the whole (in a certain station under consideration, slightly less than 20 per cent) and there is a balance of 690 horse power instead of 245 horse power. In other words, the feed water is just as hot, and there are 445 horse power extra developed by the main machines. The gain all comes from the fact that the turbine uses steam much more efficiently, even in the early stages, than does the ordinary steam-driven, slide-valve engine. The 245 useful horse power is needed for auxiliary driving in any case.

These figures in regard to feed-water heating are taken from a plant now in operation. The plant itself lies within fifty feet of the point where this paper is being written. It has been in operation for nearly two years, and the feed-water temperature is 216 degrees, the steam pressure within turbine casing being 2½ pounds gauge pressure. This pressure varies with the load on the turbine and with the demands for low-pressure steam for other purposes, and with it the temperature of the feed water. At times the available pressure is below the atmosphere; but the proper amount of steam goes to the heater whatever the pressure may be.

The station itself is turbine-driven, and that part of it devoted to power purposes is of 10,000-kilowatts capacity. Each turbine has its own condenser with the regular system of auxiliary apparatus.

There is, however, in the turbine casing at the point where steam is normally at about atmospheric pressure, an opening for the eduction of steam for various purposes. The pressure at this particular point varies just as does the pressure in the receiver of a compound engine, though the actual pressure is considerably less than that in the usual receiver. A branch pipe is led from this opening to a low-pressure steam main from which the closed feed-water heaters draw their supply of steam. The opening into the feed-water heater for steam is 8 inches in diameter. There is no opening for steam outlet. Whatever steam goes into the heater is condensed and passes out as water.

In any closed heater having a single opening for steam, with no steam outlet, there must be provision made for draining the low-pressure portion of the heater of condensed steam and of air. The chambers must not become water-bound, and above all must not be air-bound. If the pressure within the heater casing is always above atmosphere the drainage problem can be solved without special provision. When, however, the pressure drops to atmosphere or below, something must be done with the air as well as with the water.

In the station under discussion the lower portion of the heater shell is tapped for a 2-inch pipe and a bucket trap is placed below the heater body. The discharge of this trap is led to the condenser of the turbine. There is, besides this opening in the heater shell, a short air pipe within the body high enough above the low point so that water will not enter the orifices. This pipe is led through an air trap to the condenser. The air trap is nothing more than an ordinary expansion trap. If the vapors coming through the trap are of low temperature, the valve opens and the contents pass into the 28-inch vacuum. If the vapors are at high temperature, it matters not whether they be air or steam, the trap closes automatically and there is no chance of escape. The bucket trap acts in a similar way when handling water. If there is water there, the valve opens and it passes straight into the condenser. When there is no water the trap closes its valve and there is no such outlet. In other words, anything that is hot and that is of value in heating feed water stays within the heater casing; if it is cold it passes over to the condenser.

The volume of vapor and water is no greater than the turbine itself can deliver, for every bit of the mass in the low-pressure portion of the heater has passed through the early stages of the turbine so that no extra work is placed upon the condensing system.

The piping connections and all joints must be tight. This is true with the condensing system, in any case, and the added joints and added attention are trivial—in fact, too small to be measured. In order to make a test of the amount of current used by the electric-driven pump for the heating of feed-water alone, electric meter readings were taken from the pump's motor when the station itself was not running and when the demand for steam was that of low pressure.

The current consumed in this case amounted to 8 kilowatts and there were at the time 75,000 pounds of water per hour being heated. This current is greater than would have been used had the turbine been in operation, because at the time a vacuum of 28 inches was being maintained in the condenser and throughout the wheel casing of one turbine without a bit of steam passing through the turbine or condenser in question, so that all stuffing boxes of valves and the like which under regular conditions, had they leaked at all, would have passed steam outward instead of leaking air inward increasing the amount of air to be handled very materially; but even were 8 kilowatts to be charged against the feed-water heating system, the results are still very much in favor of the electric-driven auxiliary apparatus as described.

There is another condition which militates favorably in such a system, and that is that all of the exhaust which enters the heater is condensed and the temperature of the water depends merely upon the surface in the heater. There is always an abundant supply of steam to draw from; that is to say, the steam is taken from a large and abundant reservoir just as it is needed. When the exhaust of the auxiliaries is the sole source of feed-water heating, if by chance the exhaust is greater in volume than the heater will condense at the time, the surplus is wasted. If, on the other hand, the supply is too small, the feed-water heater is not efficiently used and the feed temperature drops.

It is sometimes thought that a large air pump is a very inefficient machine for handling comparatively small amounts of air, and the reason given is that the piston of the pump is drawing against the vacuum all the time and there is 14 pounds pressure on every square inch of the piston to be overcome by the motor. This idea is wrong, however. The work on the pump is nearly proportional to the amount of air handled, regardless of the size of the pump. If the amount of air is less than the pump is capable of delivering, the pressure on the atmospheric side of the piston itself is balanced, or nearly so, for a good portion of the cycle. This can be demonstrated mathematically and has been demonstrated by actual measurement on these air pumps. The maximum load on the pump occurs when the vacuum is about 18½ inches, varying with clearance. If the vacuum is less than that, the load falls off because of the decreased difference in pressure. If the vacuum is greater, the load falls off from the decrease in the mass of the air handled. The curve below is a record of a trial made on a pump to demonstrate this, and the analytic demonstration is also given. The record of the trial of the pump does not present a perfect and uniform curve because the pump valves are mechanically operated, and for the low vacuum they can be adjusted only by the sound

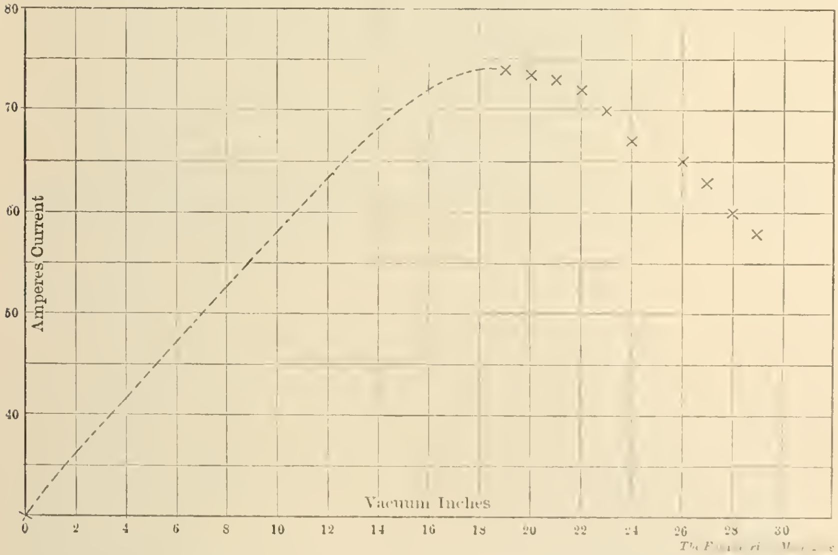
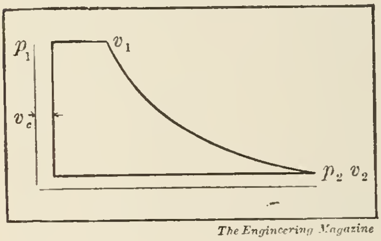


DIAGRAM OF TEST OF AIR PUMP, SHOWING POINT OF MAXIMUM LOAD.

For demonstration see following page, footnote.

which the mechanism gives out; but the curve in general is correct and demonstrates the point. The readings were taken down to 18½ inches vacuum. Below that point only one reading was to be had, i. e., that at 0 inches.

There is another great advantage in the electric auxiliary, that is to say in its convenience and its ease of operation. The twenty-nine motors here listed are cared for, including all ordinary repairs, by one man, and it takes one-half of his time; that is to say, five hours out of each of his ten are devoted to the motors. It would be difficult to conceive of twenty-nine engines of various sizes up to 60 horse power, scattered over a large building, some at the very top and extreme end and others in the basement, running properly when receiving such a limited amount of care. These motors have been running in this way for nearly two years.



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$$\text{Area} = A = p_1 v_1 + \int p\,dv - (p_1 v_c + p_2 v_2 - p_2 v_c) = p_1 v_1 + p_1 v_1 \log v_2 - p_1 v_1 \log v_1 - p_1 v_1 - p_1 v_c + \frac{p_1 v_1 v_c}{v_2}$$

$$\frac{dA}{dv_1} = 0 = p_1 + p_1 \log v_2 - p_1 (1 + \log v_1) - p_1 + \frac{p_1 v_c}{v_2}$$

$\therefore$ Area is greatest when, $\log_e v_1 = \log_e v_2 - 1 + \frac{v_c}{v_2}$

$p_1 = 14.7 \qquad v_2 = 1 \quad v_c = .03 \qquad \log_e v_1 = -.97 \qquad v_1 = .379$

That is, the area is maximum when v_1 is .379.

The corresponding value of p_2 is 5.6 lb. or a vacuum of 18.3 ins. mercury.

NEW SHOP METHODS FROM THE MACHINIST'S POINT OF VIEW.

By W. Burns.

Questions which involve human individuality on both sides—and most questions of modern shop management are of that sort—can not find stable solution until each party has seen clearly the other's position. He may not be willing or able to occupy it himself, but he must understand what it is and what relations it has to his own stand. Mr. Burns' article is presented for the value of the hints it may give, to the employing engineer, superintendent, or manager, of the ideals and the attitude of mind of the man in the shop.

The problem of the supply of skilled mechanics for the future has weighed upon some very able and earnest employers; some side with Mr. Burns in believing that modern methods are destroying, or atrophying, the very skill in the individual upon which it must find its basic foundation. We are inclined rather to side with those who believe that there will always be those workmen who (to quote Mr. Burns) "by constantly thinking and planning when at work for quicker and better methods, have become very expert"—in other words, that there will be lack neither of material nor of opportunity for the development of the toolmaker and the highly skilled specialist on operations and processes. Collaterally, there will be developed still larger field for the employment of labor formerly wholly unskilled, in partly skilled work, immensely greater in volume and better in pay.

The process seems analogous to every preceding phase of the introduction of machinery. Eventually, it works for the advantage of all; but the time of transition is painful for many individuals, and it is a grave duty to the employer to rise to his responsibilities to lighten the burden of the worker, so far as possible. Mr. Burns' theme leads back very nearly to the text of Mr. Becker's article, in preceding pages of this number.—The Editors.

IT may not be amiss, in these days of progress in machine-shop methods when our attention is directed to the performances of the high-speed steels—their advantages over the ordinary carbon steels, the particular manner in which they should be made and used to insure a maximum output— to draw attention to a phase of the subject of which comparatively little is said, namely, the view of the operative.

Until some few years ago, the machinist was allowed (to a large extent) to operate on the particular piece of work given him according to his own ideas of what was fit and proper, having tools dressed and ground as he wished and choosing his own speeds and feeds. More recently, however, and especially since the advent of the high-speed steels, conditions have greatly changed. Employers, realizing the vast saving in time possible through the use of these steels on work where much machinery was required, naturally turned their attention to the possibility of reducing the time necessary for each separate operation. For the result, we have tool rooms where tools ready for use are stored, and given out to the machinist as required, the grinding being done by unskilled labour on a special grinding machine. Where repetition work is done, jigs and fixtures are used to reduce the time required for setting up work, and to insure that the finished pieces will be interchangeable. In addition, on certain classes of work, jigs are specially designed to be used by unskilled labour. A constant effort is directed toward the shortening of the time of the skilled machinist, his part of the work being limited to that on which skill is necessary; and a collateral effort is made to keep him constantly at the machine, and the machine always going.

In this way the cost of production is very much lessened, which is no doubt satisfactory to the employer—but what about the employee? The employer, having discovered the value of providing appliances to facilitate work, has hired highly paid specialists to plan out the lines on which the work should proceed, and to design and make suitable tools; or, to put it in another way, he has taken those workmen who, by constantly thinking and planning when at work for quicker and better methods, have become very expert, and has employed them to do the thinking for their more easy-going and perhaps less-gifted neighbours.

The average machinist working under these conditions can turn out a large quantity of work, and will continue to do so and to improve if kept constantly at it; but, should he after working in this way for some years be put to a different machine, or go to a different class of work, it will take him a considerable time to become proficient. He will find that owing to his not having to do much thinking when engaged in the routine work of the other machine, it is much harder for him to think out how to go about the work, even though at this machine he be provided with the same facilities for turning out work as at the other.

The difference is not so marked if the machinist has (as most old machinists have) a fairly general experience on two or three machines; for though this knowledge is somewhat forgotten, he still has the groundwork, and in a short time is able to produce work as quickly as others. But take the case of a young machinist brought up in a modern shop, who has been kept mostly on one class of work; should you change him on to another machine he would simply not be able to make a show of work at all, unless perhaps he has very carefully watched and studied how this machine is operated, which is generally impossible unless this particular machine should happen to be situated near the one on which he gained experience. In some shops even this would not amount to much, as the operatives are so constantly watched over that should one be absent from his machine for five or ten minutes some official would be round looking for him. Had this young machinist been taught under the old order of things, when he would perhaps have few tools and less appliances, he would have found it necesssary to do some thinking and scheming to get his work done; consequently he would be better able to take in hand a different machine, as he would be familiar with more than one way of setting up work and using tools; the scheming he had at the other machine would assist him also in overcoming any difficulties which might arise.

Brought up under the new order of things, a young machinist would in a given time turn out better work and far more of it, as he would then be able to direct his entire attention to the actual cutting operations on the work, and these would be made easy by reason of appliances and tools suitably designed. But should you put him on a different class of work he would be at a loss till he had again become familiar with the tools and appliances. If in the course of his four or five years' apprenticeship he should get experience on three or four machines, his knowledge would be limited to that he has gained in the using of prepared machines and tools, and it will be nearly impossible for him to think out different ways of doing work and using tools. He would perhaps be able to suggest some improvement on the way in which some particular operation should be performed, but if you questioned him you would probably find that beyond the details of the operation he knew practically nothing—what the part was to be used for, why this part was finished, this part left rough, this portion to pass a limit gauge, what practical limit of error might be allowed; he would probably tell you that he did not know; his instructions were to make it that way.

Should this young man in quest of a bigger pay go to another shop—unless he happened on a shop doing exactly the same class of work and on a machine he had previously worked—he would be at a loss, and for some time would have to work at a lower rate of pay—that is, if the foreman judged he would eventually be of some use and if times were busy; but were times slack and an old hand should happen to ask for a job, the foreman would probably take the easiest way and shift the young man on the first pay day. He goes into a small job shop and wonders how it is possible for work to be turned out in a place like this, with no proper machines or tools; he will tell the men working there what machines they ought to have—but he will not be able to work there. If he is a young fellow with grit in him he will not be discouraged by this, but will make up his mind to watch and learn all he possibly can of the different machines and methods of working, as he will soon realise that even if he has a special knowledge and can make good pay when working one particular machine, this knowledge will be of little value should he for any reason be thrown out of work.

The average older machinist, having been accustomed during his apprenticeship (when work was not so much specialized as it is now) to work on any and all sorts of work, with tools and without tools, appreciates the facilities for doing work, and is able to make full use of them; but the work not lasting long enough in one shop, he has to go to another, hence it is necessary for him to be continually observing how the work is being done by others, as he does not know how soon he may be doing the same work. By shifting from one shop to another he soon acquires a wide range of knowledge which makes him a much more valuable man both for himself and his employer. His knowledge is "cosmopolitan," is readily available, and he is able to suggest improvements seen in other shops. Working in one shop and on the same work for any length of time, and under modern conditions, he will find it very difficult to start anew in a strange shop.

Of course the older machinist has to judge for himself what he thinks will pay him best—whether to settle down in one shop or move about; but in the training of the young machinist, would it not be to the advantage of the employer and employee that the latter should, while supposed to be learning a trade, not be looked on altogether as a profit-producing unit, but rather as a young man to be instructed in the broad general principles relating to machines and the machining of metals? Where, in after years, are the men to come from who will help forward in the march of progress by improving on old machines and devising new, if the young machinists of today are trained up as specialists at one machine? A knowledge of machinery cannot be acquired save through the actual doing of work, and routine work does not tend to promote thought. The jig designer and tool maker requires to have a knowledge of machinery, to improve on existing jigs or to devise new, as his work is so intimately associated with that of the machinist, and it is fair to assume that men trained as tool makers will make but little progress without the aid of the experienced machinist.

EDITORIAL COMMENT

THE relation of the engineer to the economist is one which has occasionally been noted, and which is appearing with increasing force as time progresses. Thus an examination of the important papers of the past month, reviewed in these pages, shows that many questions of economic importance really depend upon the work of the engineer for their solution, and that statesmen are largely dependent upon the well-considered direction of the forces of Nature for the use and convenience of man for their conduct of the policies of government.

It is already well recognized that the railroad is the most effective instrument in opening up and developing new colonies, and that no scheme of colonization is of value which does not include modern transportation facilities. The railway from the Cape to Cairo is being pushed from both ends, not so much because of a demand for overland transport as because of the effect which such a bond must have in consolidating British influence throughout the length of the continent of Africa, while in like manner the lines which have been run in from the coast to the internal water communications are far more potent influences for commerce and civilization than any military or diplomatic effort could possibly have accomplished.

All the intriguing of Russia or effort of Japan was as nothing in the Far East until a line of railway communication was opened from the Urals to the Pacific coast, and the engineer had to precede the soldier and the diplomat here as elsewhere. Now the work of the same pioneer of construction must make good the waste of the men who, after a lamentable exhibition of inefficiency, even in their chosen department of work, have abandoned the field to the man who can "do for one dollar what any fool can do for two"—to the engineer, whose constructive ability is depended on to repair the waste, to develop the mineral wealth and the industrial productivity of the land which the so-called economists have been able only to impoverish.

In like manner the contentions of labor and capital are continually rendered futile by the introduction of appliances and methods which wipe from the record the very objects of discussion, and make the hard-learned lessons of experience and the subtle arguments of philosophers alike ancient history.

Much of the power of organized authority has heretofore depended upon the control of communication and the manipulation of publicity, but the engineer enables the sources of intelligence to be thrown open so that anyone who chooses may send his messages through the ether, to be picked up by anyone else who will, and communication through space succeeds communication through the official channels. Thus the engineer is the true liberator, and by his control of the great sources of power in Nature supersedes the repressive efforts of politicians—becoming the real economist, and laughing at the solemn deliberations of legislators and authorities, or watching them laboriously attempting to overtake the progress which they are alike unable to restrain or to direct.

* * *

WE have referred already in these pages to the importance of the experimental work accomplished by the United States Geological Survey in connection with the investigations of the coal-testing plant at the St. Louis exposition. Both in the preliminary report of the committee in charge, and in the articles by Mr. Parker in this Magazine, it was made evident that the results would be of great scientific, technical, and commercial value, even within the moderate range covered during the continuance of the exposition. It has been practically decided to extend the work of this department of the Geological Survey, not only to complete the study of American fuels, but also to include an investigation of the properties of materials of construction.

In response to a resolution of the Senate, the Secretary of the Interior has recommended that the investigation of fuels and structural materials be continued, and that the sum of $350,000 be appropriated for the fiscal year commencing on July 1st, the Director of the Geological Survey having estimated that $200,000 will be necessary for the continuance of the coal-testing work, and $50,000 for the removal of the plant from the exposition grounds in St. Louis to another site. The balance of the appropriation, namely, $100,000, is recommended for the investigations of materials used in building and construction work.

This latter undertaking is practically an extension of the work already conducted by the Forestry Bureau in determining the strength of timber, and the efficiency of methods of timber preservation, and at the present time is intended to include investigation of sands, gravels, stone, cement, mortars, and similar materials most closely allied in their nature with the work of the Geological Survey.

There is precedent for the conduct of such work by the Government, and the communication of the Director of the Geological Survey to the Secretary of the Interior cites the remarkable development of the Mechanisch-Technische-Versuchs Anstalt at Berlin, and its growth into the present Königliche Materialprüfungsamt at Gross-Lichterfelde. Germany has most undoubtedly benefited by the work of this Government testing station, and there is every reason to believe that the work which has been so well done in connection with American coals may be extended to advantage to other products of Nature capable of being directed to the use and convenience of man.

* * *

An interesting feature of the proposed work of the Geological Survey in connection with the investigation of the various materials of consumption and construction is the co-operation which has been extended by many scientific and technical organizations.

The four national engineering societies are represented in the national advisory board, and other organizations are included among the bodies which have selected representatives, so that there is every reason to believe that the work of the Geological Survey will be guided in a manner which may lead to its conclusions being accepted by the men who are using the materials subjected to investigation. It is not impossible that this may prove the beginning, in the United States, of the establishment of a standard system of testing all materials of construction in such a manner as to give results comparable with the work done in other parts of the world. This would do away with much of the laborious conversion and revision now necessary.

* * *

More than two years ago, in the issue of this Magazine for February, 1904, M. Henri Dupays discussed the applicability of alcohol as a fuel for the internal-combustion motor, and showed the results of the tests in France and Germany upon stationary and automobile motors. It was there shown that the only obstacles to the development of this important industry were those imposed by restrictive legislation; the engineer had fully demonstrated his portion of the question, and it was only the legislator who was impeding the advance of an important element in national wealth. This state of affairs is not a new one, but in justice to the politician, he appears now to be endeavoring to catch up with the progress of other members of the community, and to be really trying to do something which shall be of value to the world.

It is seldom, indeed, that the testimony before any Congressional committee is so unanimously and overwhelmingly on a single side of the question. The chief points in the plea of the advocates of tax-free alcohol for industrial use are:—

First, that it would add at once and enormously to our resources of fuel, in one of the most convenient forms for employment, either for domestic purpose or in the rapidly developing internal-combustion motor. The increase would be not only in the addition of alcohol "in being," so to speak, but in the potential increase of this industrial but non-potable alcohol from many sources now neglected and thrown to waste.

Second, as an outgrowth of this, that it would open wholly new opportunities to the farmer in the way of heavy and easily grown crops, such as the coarser sorts of potatoes, which would thus attain value as sources of crude alcohol.

Third, that it would release many industries, now using grain alcohol, from a burden of evidently needless taxation.

Fourth, that many other industries now using wood alcohol, because it is much cheaper than taxed grain alcohol, would at once reverse their practice when the removal of the tax reversed the order of cheapness; thus there would be removed at a stroke one of the curses of manufacturing operations—wood alcohol, comparable in its injurious effect on the health of operatives to the more dreaded, because more widely known, lead or mercury.

The only objection suggested—and it appeared to lie only in the minds of certain Congressmen—was a possible diminution in internal-revenue receipts. And even this is questioned by those best able to estimate the effect.

The report of the hearings before the committee on ways and means of the House of Representatives seems to show that that body is actually learning what the rest of the world has known for several years; namely, that even if there were some temporary decline in revenue, it would be a matter of immense net benefit to the community if the tax on alcohol, prohibitory now so far as fuel or industrial use is concerned, were remitted upon denaturization, under proper safeguards of Government supervision, and people were thus permitted to make something useful out of valuable material which they are now compelled to throw away. It is almost too much to hope that Congress will act with sufficient promptness to enable the United States to catch up with the countries on the other side of the Atlantic which have already removed this burden from an important industry, but at least they have begun to discover, by dint of tedious and expensive hearings, what they might have learned long ago by perusing the back numbers of the technical press of their own country as well as the papers of France and Germany.

* * *

THE recognition of Industrial Engineering as a definite field in the profession has seemed to us a necessary development of the trend of modern industrial practice. We have more than once in these pages expressed our surprise that none of the great colleges and none of the great "endowers" had heretofore realized the demand for a course which should fit the graduate specifically for command—of course, as subaltern, to begin, but still for command—in manufacturing establishments. It has become already the destination of a large proportion of the graduates of most of the technical schools, and the proportion will increase. But while we have long had courses specialized in several departments of civil engineering—while mechanical engineering students have had opportunities to concentrate their attention upon stationary, marine, or locomotive practice—while, in fact, every branch of the long recognized divisions of the profession has been carefully sub-divided so that the student may follow the line of training which will best fit him for the labors he expects to take up—what has been offered to the man whose taste, or family tradition and interest, dictated for him the choice of a career in the management of a shop building, say, machine tools, or manufacturing soap? The nearest he could come to his needs would probably be, on the one hand, stationary steam engineering, and on the other, analytical and applied chemistry.

Something has been done, it is true, in several of the schools, in the way of giving lectures on certain features of Industrial Engineering which would at least open the students' eyes to their existence. But we are glad to see a yet more positive and definite step in this direction taken by the Clarkson Memorial School of Technology in the establishment of the course on "Economics of Manufacture" as part of the work of the junior year for the engineering students. The syllabus of Mr. Graffam's lectures seems to us to indicate a fuller concept of the scope of Industrial Engineering than has yet been shown by any other technical institute, or than has yet been embodied in any other scheme of technical instruction. It has been our conviction that the proper and necessary first step in putting this new branch of technical education on a definite foundation upon which it could build further, was the establishment of a chair in one of the recognized schools. Given such a focus, further crystallization should be rapid. The Clarkson effort in this direction, so far as our knowledge goes, is the best considered and best proportioned which has yet been made.

* * *

Mr. Becker's discussion of "The Square Deal in Works Management", which closes in this issue, has been (we believe) a just and adequate review of the policy as it appears to its advocates and a true exhibition of the practice of many successful managers. But it must be frankly admitted that there is another side. Mr. W. S. Rogers voiced the feeling of an earnest and conscientious section of the "Opposition" at a recent meeting of the American Society of Mechanical Engineers. After telling vividly of the discouragement met by his company in getting mechanics to leave town for work amid surroundings that were already ideal, so far as the pleasures of simple, healthful life are concerned, he sums up the new movement thus:—

> "If our 'financial engineers' and captains of industry—so-called, but better termed 'pirates of industry'—had begun twenty-five years ago putting this surplus upon their employees' wages . . . the working-man to-day would be able to buy his own home in a place suitable to himself, and would have educated his children and felt himself to be a really free and independent American citizen, such as the framers of the Constitution of our country intended. Instead of that he has become a subject of paternalism, and we so-called captains of industry are trying to tell him how he must live, where he must live, how he must sleep, and a lot of other stuff that he knows as well as we do is simply bosh."

There is too much truth in this to be pleasant; nevertheless, though the idealists may be tainted with publicity-seeking and inclined to paternalism, they evidence an awakening of conscience which is hopeful of better things.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

NICKEL-VANADIUM STEELS.

PHYSICAL AND MECHANICAL PROPERTIES OF ALLOY STEELS CONTAINING VARIOUS PROPORTIONS OF NICKEL AND VANADIUM.

Leon Guillet—Revue de Métallurgie.

WE have reviewed in these columns the reports of M. Leon Guillet upon the properties of certain nickel steels, and also his researches upon vanadium alloy steels. We now have, in a recent issue of the *Revue de Métallurgie,* a study of certain alloy steels containing both nickel and vanadium, together with determinate proportions of carbon, the results of which are interesting.

In his earlier researches M. Guillet emphasised the importance of specifying the carbon content of an alloy steel, in addition to the percentage of metallic alloy, and most of his investigations have been conducted upon two groups of steels, one of moderately low carbon, 0.120 to 0.200 per cent., and the other a high-carbon steel, about 0.800 per cent.

Briefly, the properties of the nickel steels in these two groups are as follows: with a steel of 0.120 carbon there is a perlitic nickel steel, containing up to 10 per cent. of nickel; a pure martensite steel, with a nickel content from 10 to 27 per cent.; and a gamma-iron steel with a nickel content of more than 27 per cent.

With a steel of 0.800 carbon the alloy has a perlitic character up to 5 per cent. of nickel, while the martensitic structure exists when the nickel content lies between 5 and 15 per cent., and the gamma-iron alloy appears for nickel contents above 15 per cent.

The perlitic nickel steels have nearly the same properties as carbon steels, the tensile strength gradually increasing with the increase in nickel content, these steels being also more homogeneous and less brittle than carbon steels. The martensitic steels have a very high tensile strength and elastic limit, low elongation, and are brittle and extremely hard. The gamma-iron steels possess a very low elastic limit, a great elongation, and a remarkable resistance to shock.

The vanadium steels are also divided into two groups according to their carbon content, and each of these groups into three classes, according to the proportion of vanadium.

The first class of the vanadium steels is that having a perlitic structure, this appearing in steels of 0.200 carbon content with percentages of vanadium up to 0.7 per cent., while for steels of 0.800 carbon the limit of vanadium content is 0.5 per cent. When the proportion of vanadium in the 0.200 carbon steel lies between 0.7 and 3 per cent. the steel is of a perlitic structure containing a special constituent, the vanadium being in the state of a carbide; while when the percentage of vanadium exceeds 3 per cent. for the low carbon steel, and 7 per cent. for the high carbon steel the whole of the carbon is in the state of a carbide.

The properties of the vanadium steels of the three groups are summarized as follows:

So long as the vanadium exists in the state of solution in the iron the tensile strength and the elastic limit are increased, the elongation and reduction in area of the test piece slowly diminishing, while the brittleness and hardness are very slightly increased with the increase in the percentage of vanadium. When the vanadium is in the state of carbide and there yet remains any perlite in the alloy, the tensile strength and the elastic limit diminish, and the brittleness and hardness are also reduced with the increase in the vanadium content. When all the carbon is in the state of a carbide the alloy possesses properties which vary but slightly with changes in composition. The tensile strength and the elastic limit are both low, with a fair degree of elongation, the steel being at the same time very brittle.

Having thus ascertained the properties of the nickel and the vanadium alloy steels, considered separately, M. Guillet has proceeded to investigate the influence of these elements when used jointly. For this purpose he has had prepared at the steel works at Imphy a series of such alloys, following as before the plan of studying two main groups, one having a carbon content of 0.200 per cent., and the other 0.800 per cent.

With the introduction of another element the possible combinations naturally increase in number, but M. Guillet has succeeded in weeding out those which are unsuitable for practical purposes, and then determined carefully the properties of the remaining alloys.

Taking up first the normal steels, or those which have not been subjected to any special heat treatment for the purpose of annealing or tempering, these may be divided into six classes, these including:

1. Perlitic steels,
2. Steels containing carbide and ferrite,
3. Martensitic steels,
4. Steels containing martensite and carbide,
5. Gamma iron steels,
6. Gamma iron and carbide steels.

M. Guillet gives numerous microphotographs of these alloys, and data and results of mechanical tests, and shows that a conspicuous effect of the addition of vanadium to the nickel steels is to moderate the abruptness of the changes between the several classes.

Leaving aside a number of the alloys which are of interest to the scientific investigator alone, and confining this review to the steels which have immediate uses in the constructive arts, we note first, that in the perlitic steels, those containing, for 0.200 carbon, from 2 to 12 per cent. of nickel, the tensile strength and the elastic limit are both materially increased by the addition of small percentages of vanadium. In no case should the vanadium content exceed 1 per cent., the best results being secured by the use of 0.7 to 1 per cent. of vanadium. Thus a steel containing 0.200 carbon, 2 per cent. of nickel, and 0.7 per cent. vanadium showed a tensile strength of 91,000 pounds, an elastic limit of 70,000 pounds and an elongation of 23.5 per cent. With 1 per cent. of vanadium, the ultimate tensile strength increased to 119.500 pounds, and the elastic limit to 91,000 pounds, the elongation falling to 22 per cent. A nickel steel of 0.200 per cent. carbon and 12 per cent. nickel gave, with 0.7 vanadium, a tensile strength of over 200,000 pounds per square inch, and an elastic limit of 172,000 pounds, the elongation being 6 per cent., while with 1 per cent. of vanadium the tensile strength rose to 220,000 pounds, and the limit of elasticity to 176,000 pounds, the elongation remaining unchanged. When the vanadium content is increased above 1 per cent. the tensile strength falls off, and the material begins to show evidence of brittleness.

Similar effects are produced for steels of the higher carbon, but in a lesser degree.

When the nickel-vanadium steels are subjected to a tempering process the beneficial effects of the vanadium are still further emphasised. The tempering experiments of M. Guillet were conducted by heating the steel to a temperature of 850° C., and cooling in water at 20° C. These experiments showed that a material influence was exercised upon the perlitic steels. The tensile strength and the elastic limits were increased, being nearly doubled for the low nickel content. Thus the 0.200 carbon steel with 2 per cent. of nickel, untempered, and containing 0.7 per cent. of vanadium, gave, as we have said, a tensile strength of 91,000 pounds, with an elastic limit of 70.000 pounds. The same steel, tempered from 850° C., showed a tensile strength of 168,000 pounds, and an elastic limit of 150,000 pounds, the resistance to shock, and the hardness being also increased. This is one of the most notable features about these alloy steels, and should be given especial attention by engineers and constructors. The martensitic steels are also hardened by tempering, but the effect is not so marked with the perlitic steels.

M. Guillet's paper contains much that will interest the engineer and metallurgist, but for the constructor the principal points to be gained from his investigations are these:

The addition of vanadium is of value, so far as can be seen at present, to steels containing from 2 to 12 per cent. of nickel, and in no case should more than 1 per cent. of vanadium be used. The result is to increase both the tensile strength and the elastic limit, especially if the steel is tempered by heating to about 850° C. and cooling in water at atmospheric temperature.

These results are what might be expected from a consideration of the effects of nickel and of vanadium upon steel considered separately. An especial feature of interest is that very small additions of vanadium may be used to produce very marked effects upon nickel steels.

AN EXPERIMENTAL STUDY OF CONDENSER PROBLEMS.

THE INFLUENCE OF THE PRESENCE OF AIR IN SMALL QUANTITIES UPON THE SURFACE CONDENSATION OF LOW-PRESSURE STEAM.

James Alexander Smith—Victorian Institute of Engineers.

At the present time, and especially in connection with steam turbine operation, the important relation between a high vacuum and good economical performance in steam engines is generally appreciated. From the days of Watt the necessity of removing the air from the condenser has been understood, the impossibility of obtaining water free from air in solution being known, but there is more than one reason for this necessity, and apart from the fact that the air itself tends to vitiate the vacuum, it has been found to exercise a peculiar influence upon the performance of condensers of the surface type. In a paper recently presented before the Victorian Institute of Engineers by Mr. James Alexander Smith, the results of some experimental investigations into the performance of surface condensers are given, and some points of practical value are brought out.

In the earlier experiences with the condensation of steam the expansion in the cylinder was carried down, perhaps to one-eighth or one-tenth of the initial, and even in multiple-expansion engines the expansion ratio rarely reached one-twentieth of the initial pressure in the high-pressure cylinder. Under such conditions the mixture of air and steam in the condenser was such that the heat was rapidly abstracted by the cold tubes of the surface condenser, and a fair vacuum was readily maintained. With the steam turbine, however, the expansion is carried to far greater ratios than was possible with the piston engine, and the exhaust is delivered to the condenser at lower pressures and temperatures than was formerly ever experienced. As a result the conditions in the condenser are altogether different. The older data as to the condensation of steam, based upon the older experiences, are therefore inadequate to serve as reliable guides, and generalisations derived from incomplete investigations of pure steam should not be assumed to be applicable to mixtures of steam and gas. The experiments of Mr. Smith have shown that such assumptions are fallacious, and that the presence of air in quantities that might have been deemed insignificant may, in fact, become the factor limiting the efficiency of a whole steam plant. For instance, air equal in pressure to only 1-20th of an inch by the mercury gauge will, at a temperature of 90° F., reduce thermal transmission some 25 per cent., while 3-20ths will lower it about one-half.

It must be remembered that air is one of the poorest conductors of heat, and that the relative proportion of air in a mixture of air and steam determines the rate of transmission of heat through the mixture. With very low pressure steam, therefore, the important effect of air in the surface condenser lies in the manner in which, to use Mr. Smith's expression, it blankets the tubes and prevents them from doing their work to the best advantage.

The physical conditions existing in the surface condensation of steam are examined critically by Mr. Smith, and such conditions should be fully considered in the practical problem of condenser design. Given a vapor differing insensibly in temperature from that of the fluid at the same pressure, then it is at its critical point and the slightest abstraction of internal energy through the walls of the containing vessel will determine the liquefaction of a portion strictly in accordance with the energy transferred. Thus, in the case of pure saturated steam—that is, steam at its critical point—in contact with an energy absorbing, or cold surface, the most intense volume change, where the latent heat is given up or the molecular paths alter in extent from that traversed as steam to that traversed as water, is immediately at the surface. In the case of steam, given an energy sink in the form of a cooler environment, the chief limit to the rate of change is the time required for the internal energy existing as molecular motion in all directions to become in part energy of motion in one general direction of approach; in respect to the walls it is the transmitting capacity of the molecules, that is, the thermal conductivity of the solid.

Permanent gases do not even remotely approximate to their critical points at condenser temperatures. There is no selective reduction of a portion of the molecular paths, but a general, although slight, reduction of all as a consequence of cooling, and the change is accompanied by a motion of approach negligible relatively to that of the steam. It logically follows that there is a radical difference between the condensation of pure steam and that of steam mixed with a permanent gas with which it does not chemically combine.

Steam progresses continually towards the surface where it becomes water, passing away in that dense state, almost without resistance, as drops or as a gliding film. The inter-diffused gaseous molecules are impelled towards the same surface, but in that direction they cannot escape. Dalton's and Graham's laws of partial pressures and diffusion make for homogeneity of mixture, but they are rigidly true only when the volume is statically constant; here the conditions are dynamic. The result is ultimate equilibrium, but not homogeneity. Since the steam condensation is chiefly evident in laminæ of minute thickness at the condensing surface, it follows that, given a moderately rapid motion of general approach, that although the gas may at first be highly tenuous, a very slight retardation of diffusion may permit of an accumulation of molecules at that laminar surface of energy change where their impedance is a maximum.

Mr. Smith has studied these actions experimentally and visually by using glass tubes containing bromine, both with and without air in the vapor space. The low boiling point, deep non-actinic color of the vapor and strong russet-red of the condensed films, render it easy to follow the processes of diffusion and condensation, and permit the results to be photographed.

In order to determine experimentally the extent to which the theoretical conclusions obtain in practice Mr. Smith has conducted a series of careful experiments, the methods and apparatus being clearly described in his paper, to which the reader must be referred. The apparatus consists of a special form of condenser, with appliances for measuring accurately the variables, such as pressures, temperatures, rates of flow of condensing water, etc., and the results are plotted in curves.

With pure steam, free from air, and with a constant flow, the temperature increment of the cooling water showed a constant ratio to the temperature increment of the steam. Experiments with varying amounts of air, from mere traces up to 0.7 inch (mercury pressure) showed the retarding effect of successive additions of air, this effect being more marked in proportion at the lower temperatures. With a temperature of 90° F. it is shown that 0.2 inch pressure of air may almost exhaust the refrigerating power of a condenser. Mr. Smith has not yet succeeded in formulating the law governing the influence of air in condensers, but some of the conclusions deducible from his curves are instructive. Thus, with pure steam, equal increases of temperature of vapor cause equal rises of the cooling water temperature, but this is not true when any air is present. At the higher temperatures the relative loss of efficiency by air addition is not so rapid as with lower temperatures, but the absolute loss in heat units is much greater in the former than in the latter case. The surface required is inversely as the cooling effect, therefore the difference in design between such limits as a condenser at 140° with pure steam, and one at 90° smothered with 0.3 inch pressure of air, is obvious. In this instance the effective ratio is about 7 : 1.

The injurious influence of the presence of air, as shown by the experiments of Mr. Smith calls attention to the great importance of preventing all possible air leaks. The water itself may contain about 1-30th of the feed volume, including mechanically entrained bubbles. Assuming leakage to be absent, and a minimum limit of 1-20th inch mercury pressure in the condenser, the effective volume of the air pump should be twenty times that of the feed pump. The difficulty of removing the air with very low pressures calls attention to the advantage of the subsidiary condenser, and when this is provided with a steam jet to sweep the residual gases from the main condenser, a smaller pump will suffice and will be more effective. In such a case the air pump should be differentiated from the water-removing pump. Apart from the removal of air, however, it is of vital importance that any leaks, however minute, of air into the condenser or into the pipes communicating with it, should be prevented as fatal to efficiency. When one thinks of each tube of a surface condenser as coated with an adherent film of air, one of the poorest conductors of heat known, and realizes that he has provided tubes of the best conducting material available, and is pouring cooling water through those tubes at the expenditure of much mechanical energy, he will realize the necessity of considering this element of the problem of the maintenance of the high vacua so essential to maximum steam economy.

CHICAGO DRAINAGE-CANAL IMPROVEMENTS.

CONSTRUCTION WORKS FOR THE DEVELOPMENT OF HYDRAULIC POWER FROM THE FLOW IN THE CHICAGO DRAINAGE CHANNEL.

Engineering Record.

WHEN the great drainage canal was built to reverse the current of the Chicago river, and cause the drainage of the city to be diverted from Lake Michigan to the Desplaines river, finally to be delivered into the waters of the Mississippi, it was perceived that a valuable source of hydraulic power was also possible. The plans for this work have been completed, and late in 1903 contracts for the construction works were awarded, and a portion of these works will be completed during the coming season. In a recent issue of the *Engineering Record* these important works are described in detail, and we give here a general account of the undertaking and its possibilities, while for structural details the reader may be referred to the very full account noted above.

"The works required to develop the power include the building of a head race 10,700 ft. long, with a uniform channel width of 160 ft. and a minimum depth in this channel of 22 ft., partially in excavation and partially between concrete retaining walls and earth and rock embankments; a 69x386-ft. two-story power house, built of concrete blocks, and a tail race in earth and rock excavation, which is 6,800 ft. long, 160 ft. wide and deep enough to afford a minimum depth of 22 ft. of water. This work involves, according to the contract estimates, 105,000 cu. yd. of earth excavation, 1,273,540 cu. yd. of rock excavation, 366,484 cu. yd. of earth embankment, 997,084 cu. yd. of rock embankment and more than 150,000 cu. yd. of concrete.

"The main channel of the drainage canal is 28.05 miles long and extends from the west fork of the south branch of the Chicago river, 6 miles from lake Michigan, to a controlling works at Lockport, Ill. From these works the flow is discharged into the Desplaines river, thence into the Illinois river and finally into the Mississippi river. Branches are to be built to the canal in order that the sewage from large districts lying along the lake to the south and the north from the district served by the main channel may be diverted from the lake into the canal. The plans of the projects of the sanitary district for relieving the lower end of lake Michigan from sewage pollution and the construction of the portions of these plans that have been carried out have been fully described already. The main canal now carries under normal conditions a flow of 300,000 cu. ft. a minute; when the extensions already projected and the contemplated improvements to the Chicago river are carried out this flow will be practically doubled.

"The bottom of the main channel of the canal at its juction with the Chicago river is 24.448 ft. below Chicago city datum, which is the water level of 1847 in lake Michigan. The canal is built on a descending grade of 0.025 ft. to the 1,000 ft. in earth and 0.05 ft. to the 1,000 ft. in rock from this junction to the controlling works. The fall in the Desplaines river valley from datum at the controlling works to the level of a large basin, 4 1/3 miles below, which was built as a part of the improvements necessary to carry the flow of the canal and the Desplaines river through Joliet, is 42 ft. The present construction is being carried on to develop this head as fully as possible."

The controlling works at the end of the main canal involve the construction of a tail race 600 feet wide and 6,500 feet long, capable of carrying 1,500,000 cubic feet of water a minute, this having been built at the time the main canal was constructed. A head race is being constructed to connect with the main canal near the controlling works, extending downstream parallel with the tail race and to the river.

"The bottom of the main canal at the controlling works is 30.1 ft. below city datum, while the natural ground surface is only 12.4 ft. below that level. The channel is thus partially in excavation and above the natural surface it is carried by heavy concrete retaining walls backed by earth and rock embankments. The natural surface is 17.5 ft. above the bottom of the channel at the upper end of the head race, and is on a descending grade from there until at the lower end of the head race it is 3 ft. below the grade of the bottom of the latter. The bottom of the head race is level with and is continued on the grade of the bottom of the main canal. The head race has therefore also been built partially in excavation and above the top of the excavation is carried on the left-hand side, going down-stream, by a high concrete retaining wall backed by a heavy rock fill, and on the right-hand side by an earth and rock embankment.

"The concrete retaining wall and the embankment back of it are a continuation of similar construction on one side of the main canal, and in the first 2,646 ft. from the end of the latter are on tangent. The top of the inner slope of the earth and rock embankment on the right-hand side of the head race is 220 ft. from the inner face of the concrete retaining wall on the opposite side. The head race crosses a highway 1,800 ft. from the end of the canal, and in this distance it is 220 to 380 ft. wide, the earth and rock embankment having been built to conform to the topography of the natural surface. A channel, 160 ft. wide and with one edge 1.5 ft. from the inner face of the high retaining wall on the left-hand side, is excavated, however, the entire length of the head race. The natural ground surface is a loamy soil, 2.5 to 5 ft. deep, which overlies a bed rock formation of Joliet limestone that is more or less seamy and contains some clay pockets. The channel is excavated through this material. The loam over the area between the sides of the head race and outside of the channel is also stripped to the rock.

"The width of the head race is reduced to 300 ft. at the highway crossing by curving the earth and rock embankment to the left to provide for a dip in the natural surface. Just beyond this crossing the embankment is turned toward the tail race of the controlling works until the width of the head race is 580 ft. and the embankment joins an old levee along the tail race. This levee is 10 to 15 ft. high and 50 ft. wide, and was formed in making the excavation for that race. The embankment follows the levee for 3,000 ft. About 700 ft. from the turn in the embankment a 1 deg. curve to the right is introduced in the retaining wall side of the head race and is continued for 3,367 ft. The embankment on the right-hand side being inclined slightly to the left in the same distance the width of the head race is reduced to 220 ft. just below a second highway crossing, 5,300 ft. from the upper end of the head race. From the second highway crossing to a point 9,700 ft. from the upper end of the head race the width of the latter varies from 220 to 280 ft. At that point a forebay for the power house 1,000 ft. further downstream, is commenced by inclining the right-hand side of the head race away from the opposite side until the width of the race at the power house is 660 ft."

It is estimated that these works will enable the available head of 32 feet to produce an available effect of 27,000 horsepower, when the full discharge of 600,000 cubic feet per second is delivered. The power house is to be designed to receive eight 4,000 kilowatt electric generators, direct-connected to vertical turbines, four of these, with an exciter, to be installed at first, with space for successive additions.

It is interesting to note that this power plant is a direct draft upon the hydraulic energy of the great lakes, as distinctly as are the plants at Niagara Falls, and that any attempt to protect the falls at Niagara from diminution must include every possiblye outlet of the higher lakes into any lower watershed.

GAS ENGINES FOR ELECTRIC DRIVING.

THE INFLUENCE OF SPEED CONTROL UPON THE APPLICABILITY OF GAS ENGINES FOR DRIVING ELECTRIC GENERATORS.

James Atkinson—Institution of Electrical Engineers.

GAS engines are now being used for a variety of purposes, and as the convenience and advantages of gas power are becoming appreciated their applications are certain to meet with wider and wider fields of service. One of the difficulties which has appeared in connection with the use of gas power for driving electric generators is that of accurate speed regulation. The dynamo should be run at a uniform speed, especially when employed for electric lighting, while the gas engine, especially in its earlier and simpler forms, is weak in this very matter of close speed regulation. In a paper presented recently before the Manchester section of the Institution of Electrical Engineers, by Mr. James Atkinson, this matter is considered in a very practical manner, and some of his points will be found of interest and value.

"The application of gas engines to electric driving commenced in a very small way some 25 to 28 years ago. In those days a gas engine of more than 2 or 3 horse-power was the exception, and such installations were mainly confined to lighting houses or shops. We look back to these installations with a good deal of interest, and though from our present point of view we regard them as insignificant and crude, they still did good work in their small way. They were the pioneers of what has grown to be an enormous branch of engineering, and it seems as though it were almost impossible to fix a limit to the magnitude to which gas-driven electric generation will grow in the immediate future. The great advances in the construction of a better type of dynamo very soon began to show the necessity of improving the driving capabilities of gas engines, both with respect to power and regularity.

"The improvement in the dynamo, however, frequently landed the gas-engine makers into trouble in the early days. Installations which would have passed muster with the crude old-fashioned dynamos were not satisfactory with more efficient machines; the lights driven by them would show every impulse given by the engine, and it became obvious that considerable changes were necessary in the engines, leading ultimately to the high-speed, heavily-flywheeled, special electric-lighting gas engine. The demands of electrical engineers for the required steadiness for all kinds of continuous-current driving are amply met by these single-cylinder Otto cycle, heavily-flywheeled engines both as regards steadiness of light or running a number of units in parallel. A very large number of such plants have been installed, some of them having been in satisfactory regular use for many years."

The great attraction of the gas power plant is its high fuel economy. The modern suction producer plant, using coke as fuel, and direct-coupled to an electrical generator has been shown to generate a kilowatt for 1,325 pounds of fuel per hour, the thermal efficiency of the plant being over 22 per cent., and the ratio of electrical energy to the heat energy in the fuel reaching as high as 20.8 per cent.

The principal difficulty with the gas engine, when applied to the driving of an electrical generator, appears in the fact that the piston receives a power impulse only at every other outward stroke, so that the turning moment is necessarily variable, and this gives a corresponding degree of irregularity to the motion of the dynamo, unless some very effective governing device is employed.

The original method of governing gas engines was by what is known as the hit-or-miss method, this being operated by causing the power stroke to be omitted whenever the rotative speed of the shaft exceeded that for which the centrifugal governor was regulated, and resumed as soon as the speed fell below the normal amount. Obviously such a method, although exceedingly economical as regards the consumption of gaseous fuel, did not give a uniformity of speed adapted to the driving of electric generators, and hence in the later machines other systems have been applied.

Four methods have been used for the regulation of gas engines, these being: throttle governing; cut-off governing; variation of the richness of the charge by throttling the gas; and varying the richness of the charge by changing the duration of gas admission.

The first method has the advantage of simplicity, and gives a good speed regulation, but it is wasteful of gas at low loads. The second system works very well for engines running at moderate speeds, but is not adapted to high rotative speeds, since the trip gear does not then work well.

Governing by varying the richness of the mixture, the third method above noted, has been occasionally adopted, but the narrowness of the range of speed regulation gives it a limited application.

The fourth method, that of varying the timing of the admission of gas, but always cutting it off at the end of the stroke at the same time, appears to be coming to the front.

The principle is used in both the Körting and the Oechelhauser engines, and it has the especial advantage of not decreasing the compression pressure. With the modern high compressions, reaching 150 pounds to the square inch or more the particles of air and gas are brought closely together, and the heat due to compression is so high that the ignition temperature is nearly reached and the combustion is correspondingly complete.

"The driving of alternating-current dynamos is an altogether different problem from that of the direct current machine, excepting when they are not to be driven in parallel, in which case the conditions are the same as with continuous current dynamos. When, however, they have to be driven in parallel very much greater steadiness is required. The writer has had to do with several installations in which alternators have been driven in parallel by means of single-cylinder Otto type engines. In these cases, however, they have been flywheeled to at least double the extent of the particulars given of the previously mentioned engines, and our old friend the long belt drive has been used, the engines themselves being fitted with a very sensitive arrangement of automatic regulation which always proportioned the impulses to the load. It is of interest to know that without this automatic regulation the alternators would not run in parallel, but with it in action they have been satisfactory.

"Probably all connected with alternating machine driving will welcome the action taken by the Standardising Committee in endeavoring to limit the periodicity of alternators to either 50 or 25 cycles per second. It must be a great relief to the makers of the machines, and gas-engine makers are enabled to fix on certain revolution speeds of their engines as standards."

Mr. Atkinson examines the distribution of the turning moment upon the crank pin, and discusses the best arrangement of multiple-cylinder machines when used for driving alternators, and calls attention to the important fact that the real measure of speed regularity is not the variation of actual rotative speed from the mean speed, but that of the angular difference of the fly wheel of the engine and that of a wheel running with an absolutely uniform rotative speed.

"One of the most remarkable features in connection with gas engines for driving electrical generators is the great increase in alternating-current machines, and such increase is still rapidly continuing. To some extent this change has been unfortunate for gas-engine makers, owing to the greater difficulties in constructing suitable engines. As, however, in most instances such engines are required to be of considerable power, more than one cylinder would be required, for this reason, as well as to give greater regularity.

"Considerable care should be exercised as to relative positions of the cranks, the flywheels, and the alternators. If it can be arranged it is desirable to build up the armature of the alternator on the flywheel itself, or at any rate directly couple it to the flywheel, without passing the strain through separate keys on the shaft. Such an arrangement works in very nicely when the cylinders can be arranged on to either one or two cranks. Should there be four cranks, as in a vertical 4-cylinder engine, it would seem desirable to use a similar arrangement, and only have one flywheel at the same end as the alternator. A considerable number of such engines have been made with a flywheel at each end, an arrangement which does not commend itself to the writer, as vibratory strains might be started up in the crankshaft itself, which under certain circumstances may be so serious as to cause fracture to the shaft. A very satisfactory method of coupling either an alternator or a continous-current machine to a gas engine is to do so by means of an elastic coupling. It is true that the cost is slightly increased, and that a larger floor space will be necessary; but this method possesses not only the great advantage of reducing the trouble of keeping so many bearings in line, but also gives a little more elasticity in the drive, and prevents risk from short-circuiting. These are advantages which more than compensate for the slight increased cost and space occupied."

ELECTRICAL MACHINERY IN MINES.

TESTS UPON THE POSSIBLE IGNITION OF MINE GASES FROM THE SPARKING OF MOTORS AND OTHER ELECTRICAL MACHINERY.

Bergassessor Beyling—Glückauf.

ELECTRIC power transmission offers so many advantages for mining operations that its use is widely extending, but it possesses one feature which demands attention and care in mines, which are subject to discharges of explosive gases; namely, the danger of ignition of firedamp and gas from the sparks and arcs which are apt to occur.

The question of the prevention of the ignition of mine gases from electric apparatus has been made the subject of exhaustive experimental investigations in Germany, and in recent issues of the German mining journal *Glückauf* there is given a review of these studies, by Bergassessor Beyling. These German investigations are by no means the first which have been made in this direction. As long ago as 1885 the subject was studied in Prussia by a special commission. In 1890 a series of investigations were undertaken by MM. Mallard, Le Chatelier, and Chesneau, for the French government, while more recently in Belgium and in England this important matter has been investigated by eminent specialists.

The present investigations were conducted in connection with the work of the Bismarck mine at Gelsenkirchen, in the Dortmund mining district, the work being conducted by a special commission, composed of Messrs. Beyling, Baum, and von Groddeck, together with representatives of the manufacturers of the various appliances tested, these being the principal electrical firms in Germany.

The appliances subjected to test included direct and alternating current motors, switches, starters, resistances, transformers, etc., the motors being operated up to 30 horse-power, under conditions approximating as nearly as possible those of actual service.

In order that the appliances should be subjected to as great dangers as exist in the worst cases in mining practice, the experiments were made in the testing gallery constructed by the Bismarck company for trials upon safety lamps and experiments with mining explosives, some modifications being made to adapt it for this special purpose.

The original gallery consisted of a timbered tunnel of elliptical section, 1.85 metres high and 1.35 metres wide, the total length being 34 metres. This tunnel is made of yellow pine staves, 60 mm. in thickness, hooped with iron rings made of I beams, and reinforced within by flat iron rings, and is provided with observation windows of heavy glass and a man hole at one end, the other end being closed by heavy masonry. In making tests upon lamps, explosives, coal dust, etc., this gallery is filled with gas drawn from a walled-up chamber in one of the deep workings of the Consolidation shaft, the gas being taken by means of a pipe and suction steam jet, and delivered to a gas holder, after having been passed through a purifier to remove the carbon dioxide. The gas consists of about 70 per cent. methane and 27 per cent. nitrogen, the balance being oxygen (corresponding to about 12 per cent. of air) and a small amount of carbon dioxide. The proportion of this gas delivered into the gallery for any test is determined by passing it through an ordinary gas meter. The gallery was prepared for the electrical tests by constructing an additional chamber at one end, into which the motors or other machines could be conveniently placed, this chamber being fitted with a special observation window.

The dangers from electric motors underground lie principally in the possibility of sparking and consequent ignition of the surrounding gaseous or dusty atmosphere. In the case of direct-current machines the the special points of danger are necessarily the brushes and commutator. In the case of alternating-current motors the danger point lies at the collecting rings and brushes. The direct-current machines have generally been considered the most dangerous so far as sparking is concerned, and no matter how carefully a machine may be constructed and adjusted sparking may be produced by sudden starting, rapidly fluctuating loads, or neglect. The alternating current motors, however, are by no means free from sparking dangers as has been generally assumed. Defective adjustment, severe vibrations, neglect to keep the collecting rings clean, these and similar causes may produce sparking quite capable of igniting the explosive mine gases. In addition to the dangers from sparking at the point of the collection of the current, there are other dangers associated with electric motors of every type. Any excessive heating in the windings may cause the burning out of insulation and the production of flame and arcs, and such accidents may occur with the best designed and most carefully built machines. Two methods, in general, have been employed by the constructors to prevent the production of explosions by motors. The first plan aims to prevent the access of gas to any parts of the motor which are liable to produce sparks, thus preventing any ignition from taking place. The second method is to enclose the motor in such a manner that any flame, due to ignited gas within the enclosure shall not be able to reach and ignite the general body of gas in the space outside.

The first plan has been carried out by enclosing the commutators, brushes, and adjacent parts in an enclosed chamber filled with oil, this acting at the same time as an insulator and as a protection against access of gas. The second plan involves the enclosing of the motor in a case, provided with openings for the circulation of air, these openings being fitted with coverings of wire gauze, so that the gas within the casing, even if it should ignite, cannot communicate its flame to the air without.

Experiments with motors of both of these types have shown that absolute safety cannot be secured by either method. The enclosed motors, while resisting various severe tests, ultimately failed by reason of the gradual entrance of the explosive gases within the case, and by the ignition of the mixture, blowing off the cover, and exposing the vicinity to danger. When the motor was enclosed in a casing in which the openings were covered with wire gauze, any sparking caused the gas within to ignite, and the heat thus produced either caused the gauze to become red hot, or else small carbonaceous particles, adhering to the gauze, became incandescent to an extent sufficient to ignite the gases without.

Herr Beyling discusses experiments made with a view of enclosing the motors in casings which shall be altogether air-tight, thus preventing entirely the entrance of explosive gases, but this is not a simple method in view of the actual operative conditions. Each motor must have its shaft arranged to communicate with machinery without, and this implies a gas-tight stuffing box, while at the same time similar connections are usually required for adjusting levers.

A number of tests have been made upon such gas-tight casings, to determine the strength necessary to resist the force of a possible explosion within, and Herr Beyling gives the results of such tests for various air and gas mixtures. Given a chamber of sufficient strength, however, the question arises, whether it is necessary to have it made absolutely gas tight, nd according to the experiments conducted by Herr Beyling and his associates, this is not necessary. If the openings communicating with the outer air are not too large, an explosion may take place within, and the burned gases be discharged without their being able to ignite the gaseous atmosphere without, and in this fact appears the best method of arranging electric motors for use underground. Although these experiments need to be confirmed by more exhaustive researches, it appears that the best method of protecting gaseous mines from danger in the use of electric motors of any kind, is to enclose them in casings of sufficient strength to resist the force of explosion of the gas which may finds its way within, and also to provide openings for the discharge of the burned gases into the outer space. Apparently this discharge of burned gases does not act to ignite the mixture which may be without, unless the opening be too large. Experiments have shown that if the opening of the casing does not exceed 1,440 square millimetres, there is no danger of ignition to the outside gases, since the expansion of the discharging gases results in such a reduction of temperature as to make ignition impossible.

Broadly, the results of these German experiments show that electrical machinery to be used in coal mines, in which the presence of explosive gases is possible, should be constructed with the greatest care, to reduce sparking to a minimum, and that such machines should then be enclosed in casings of sufficient strength to prevent the possibility of any bursting by explosion of their contents, the casings being provided with openings of sufficient size to permit the escape of the products of explosion, and yet not large enough to allow the escape of flame. There is no doubt that further experience with the behaviour of explosive gases will enable definite data for the design of motors and other appliances for coal mines to be determined, so that close regulations may be framed, but it is only by such experimental researches as those which have been conducted in Germany that reliable information can be obtained.

HEAVY LOCOMOTIVES.

A DISCUSSION OF THE DESIGN AND OPERATION OF LARGE STEAM AND ELECTRIC LOCOMOTIVES FOR MAIN-LINE SERVICE.

J. E. Muhlfeld—New York Railroad Club.

AT a recent meeting of the New York Railroad Club there was read a paper by Mr. J. E. Muhlfeld upon the subject of large steam and electric locomotives, which is interesting for several reasons. In the first place the paper, by title and matter, was a distinct recognition by railroad men that electric traction is no longer a thing to be ignored, or treated as suitable only for street and local railways. a large concession, but one which was inevitable. In the second place the paper formed the occasion of joint discussion of traction problems by representatives of both the railroad and the electrical construction interests, a feature which will doubtless be continued and be productive of much good.

Mr. Muhlfeld's paper deals, as its title indicates, with heavy engines, and in this lies much of its value, since it is with this department of work that the electric locomotive has, until recently, been considered of doubtful applicability. It so happens, however, that a single railroad, the Baltimore and Ohio system, is operating heavy engines of both types, and the most interesting feature of the discussion is that which gives the comparative results of these machines.

Several years ago the Baltimore and Ohio Railway introduced some heavy, direct-current locomotives for hauling trains, both passenger and freight, through the two-mile tunnel leading to its new terminal station in the city of Baltimore. These locomotives are of two kinds, the older being arranged for operation as single units and weighing about 98 tons each, while the later machines are designed in two 80-ton sections, operated on the multiple-unit system, so that, so far as dimensions are concerned, these engines are quite in the same class as heavy steam locomotives.

At the St. Louis exposition there was exhibited what was then stated to be the heaviest locomotive in the world, this being a duplex compound engine built by the American Locomotive Company for the Baltimore and Ohio Railway Company, this engine weighing 334,500 pounds, the entire weight being carried on the drivers. In his paper Mr. Muhlfeld gives data concerning the performances of the electric locomotives and this heavy steam locomotive, some abstract of which follows.

"During the past one year's service the combined mileage of two electric locomotives has been 121,015 miles, or an average of 5,042 miles per month per locomotive, computed on the basis of straight light and loaded mileage. The proportion of light and loaded mileage was half and half, about 200 miles per month per locomotive was in passenger helper service.

"Considering $1.25 per net ton as a base cost for fuel delivered at the power plant, the average total operating and maintenance expenses during the year for generating the current; the labor and material for the locomotive electrical and mechanical repairs; the engineer's wages; wiping, hostlering, inspecting, oiling and dispatching; lubricating and miscellaneous supplies, was approximately $34.50 per 100 miles run per locomotive. Of this amount the average cost of labor and material applied to each locomotive for the running and shop repairs, would be $3.20, or 52 per cent. for the electrical and $2.90, or 48 per cent. for the mechanical, making a total average cost of $6.10 per 100 miles run for both the electrical and mechanical repairs.

"The above figures do not take into consideration interest, depreciation, taxes nor insurance on the investment, nor do they include the expenses incident to the maintenance of such equipment at battery, feeders, third rail, bonding wires, insulation, safety cut-out switches, extra motors, etc., which is not required for steam locomotive operation. The wages for the conductor, or second man on the locomotive, has also been omitted.

"During their service considerable difficulty has been experienced with the shoes used for collecting the current from the surface third rail; the loosening, wear and breakage of pinions used to transmit the power from the motors to the gears on the driver wheel axles; the lubrication, heating and wear at the armature bearings; the flange and tread wear of driver wheel tire; derailments; stalling and breaking in two of freight trains due to slipping of driver wheels, more especially with wet rail or when tire of drivers connected in series are not of exact diameters, and in miscellaneous renewals and shop repairs.

"Steam locomotive No. 2400, which is of the Mallet articulated duplex compound type, was designed jointly by the builders and the railroad, and the construction was completed in April, 1904, after which it was exhibited at the Louisiana Purchase Exposition.

"After the closing of that exhibition the locomotive was brought to the Connellsville Division and put into regular service on January 6, 1905.

"For the purpose of increasing the capacity of an eastbound track, balancing of the power on the division, and to reduce the number of locomotives and crew required to handle heavy freight tonnage over a busy mountainous district, it was necessary to produce a locomotive with maximum adhesion for tractive and braking power, a minimum rail pressure per driver wheel, and a short rigid combined with a long flexible driver wheel base to adapt it to a mountain line having considerable curvature and gradient. To accomplish this it became necessary to Americanize foreign railroad practice by making use of the Mallet articulated feature, which permits of the use of a maximum effective wheel base, with a materially reduced rigid wheel base, and provides for a helper locomotive that can develop an average through freight train speed without excessive wear. The subdividing of the power through the use of four independent cylinders, pistons, main rods, crank pins and frames, in place of two, and the better balancing of the reciprocating parts, results in less strain on all parts, and reduces the liability for breakage and failure.

"While the draw bar pull behind the tender of two of the consolidation locomotives is about 79,400 pounds, the draw bar pull of the 2,400 is about 74,000 pounds when working compound, and 84,000 pounds when working simple. The weight of train that can be taken up the mountain by two of the consolidation locomotives is about 2,025 tons contained in loaded steel cars of 100,000 pounds capacity. The weight of train that the 2,400 and one of the consolidation locomotives can take up the grade is about 3,210 tons, contained in similar cars. The above figures are based on the locomotives operating at a speed of 10 miles per hour under fair coal and weather conditions, and with the 2,400 working in compound gear.

"The total elevation from Connellsville to Rockwood is 931 feet, the ruling grade between Confluence and Fort Hill being 1 per cent., and the total distance 43.4 miles.

"In through freight service, from Connellsville to Rockwood, the 2,400, singly, has moved, in 36 steel cars, 1,668 tons of lading, and 702 tons of cars, or a total of 2,370 tons in the cars. Adding the weight in working order of the locomotive and averaging the weight of the tender loaded with coal and water at 225 tons, it would make the total weight of the train, including locomotive and tender, 2,594 tons, about 64.3 per cent. of which was paying load.

"The actual running time was four hours, making an average speed of 10½ miles per hour. When handling this tonnage over the hardest pulls and around eight degrees 30 minutes curvature, as high a rate of speed was maintained as with through freight trains of 1,200 tons total, when handled by consolidation locomotives.

"Had this same train of cars been hauled by the standard consolidation type locomotive, it would have required the maximum hauling capacity of two locomotives to have handled it at the same rate of speed, and the average weight of the motive power would have been 304 tons, making the total tonnage of the train 2,674 tons, 62.4 per cent. of which would have been paying load.

"When helping trains consisting of consolidation type pulling locomotives having tractive power of 39,700 pounds, with 40 cars consisting of about 2,400 tons, weight of lading and cars, the 2,400 has pushed 36 of the 40 cars in the train on three and four degrees curvature, and 1 per cent grade, making an average speed of about 4½ miles per hour, and has pushed the entire train and pulling locomotive, weighing about 2,550 tons, when the pulling locomotive was shut off, at a speed of two miles per hour and maintained the working steam pressure and the normal water level for a distance of one-half mile on the same curvature and grade, and which performance could have been continued."

The performance of this locomotive for one year is tabulated by Mr. Muhlfeld, showing that the cost of labor and material for repairs, per 100 miles run, amounted to $3.16, or but little more than one-half that required for the electric locomotives.

"The average total operating and maintenance expenses during the year for fuel, water, labor and material for the locomotive repairs, engineer's and fireman's wages, wiping, hostlering, washing boiler, inspecting and dispatching, lubrication and miscellaneous supplies, was approximately $24.50 per 100 miles run. To this figure can be added an allowance on account of general repairs and renewals to locomotive, mileage credited but not actually run, difference in cost of fuel delivered at power plant and on locomotive tender, and for the maintenance of fuel and water supply plants, and there will still be a large margin in favor of the steam as compared with electric locomotive performance, under fairly similar conditions."

Mr. Muhlfeld draws the conclusion, from these comparative results, that, except under conditions where the use of steam locomotives is prohibited, the greater cost of operating electric locomotives must prevent their use for heavy railroad work. Under present conditions, this is doubtless correct, and any comparison based wholly upon operative costs, leaving out of consideration of the other advantages of electrical operation, would doubtless lead to the same conclusion. The situation is somewhat like that which appeared when electric driving was first proposed for machine tools.

It was found tha there was no material economy in power, and in many cases a positive loss, and yet the electric motor is steadily making its way in the shop to drive machine tools because of its many advantages over and above the actual cost of power. No doubt the efficiency of the electric locomotive will be greatly improved, but it must be remembered that there are other things besides the cost of fuel and repairs which enter into transportation problems, and that the successful system is the one which takes into account "all the conditions there are."

THE MANUFACTURE OF ARTIFICIAL NITRATES.

PROCESSES FOR THE FIXATION OF ATMOSPHERIC NITROGEN, AND ITS APPLICATION TO THE MANUFACTURE OF ARTIFICIAL FERTILIZERS.

Zeitschrift für Angewandte Chemie—Engineering.

FOR a number of years the chemist and technologist have been endeavoring to devise some method for utilizing the nitrogen of the atmosphere by converting it into a nitrate available for fertilizing the soil of wheat-growing districts. More than five years ago, in his presidential address before the British Association for the Advancement of Science, Sir William Crookes called attention to the necessity for providing some inexpensive form of combined nitrogen, suitable to replace the demands made upon the soil of our wheat growing areas.

At the present time the nitrogen fertilizer used is "Chili saltpetre," a nitrate of sodium, existing in natural deposits on the slope of the Andes, and mined and exported from Chili at the rate of more than a million tons a year. The total extent of the deposits is not positively known. According to some estimates the supply will be practically exhausted in about twenty years, others believe that the beds may last until about 1950. In any case the price must rapidly rise as the supply diminishes, and this is certain to occur unless some new source is provided. The whole question has been discussed at length by Dr. Albert Neuburger in the *Zeitschrift für Angewandte Chemie,* and has also been made the subject of a special article in a recent issue of *Engineering,* and as the principal point involved, the fixation of atmospheric nitrogen is really an electrical problem, and the vital question of cost depends largely upon the provision of cheap sources of motive power, the problem is one which comes well within the province of the engineer.

Dr. Neuberger classifies the methods of utilizing atmospheric nitrogen into four groups: the direct production of nitrates; the production of ammonia and ammoniacal salts; the production of cyanides and their derivatives, and the direct fixation of nitrogen and oxygen into nitric oxide, and thence to nitrous and nitric acids. At the present time the greatest interest is found in the last of these four methods, that of fixing the nitrogen by inducing it to form a chemical combination with the oxygen of the air, with which it is ordinarily associated only as a mechanical mixture. The fact that electric sparks caused a portion of the atmospheric nitrogen to become oxidized was observed by Cavendish in 1781 and by Priestley in 1786. The subject was taken up again in the laboratory by Bunsen, in 1857, but it was only when the modern dynamo, and especially the modern hydro-electric station showed the way to the production of large quantities of electricity on a commercial scale that the question could be seriously considered as a process of manufacture. During the past few years the subject has been attacked in various ways, and while it is not certain that commercial success has been attained the results are encouraging.

When electric sparks or silent discharges of high-tension currents are passed through air, the oxygen is ozonized and the nitrogen oxidized to various compounds, the principal one being nitric oxide; nitric dioxide being also produced subsequently by combination with the oxygen of the atmosphere.

"The technical electrothermic nitric acid process may be said to consist of several stages: the oxidation of the nitrogen by the spark or flame, which is effected in a kind of furnace; the reaction between the nitric oxide with oxygen to form nitric dioxide, effected in reaction chambers; the absorption of the oxides by water or some caustic lye to form nitrates and nitrites or the free acids.

"The oxidation of the nitrogen requires a high temperature, which can be produced by electrical or by other means. The most suitable temperatures of the small arcs and flames used for these reactions have been estimated from 1,600 degrees to 3,000 degrees C. They depend upon the length of the arcs and other conditions. All the estimates are uncertain, moreover; and Nernst has pointed out why this must be so. We determine the composition of the resulting gas mixture after it has cooled down; but since the cooling cannot be effected instantaneously, too little will, as a rule, be found of the compound which was formed at the highest temperature. Nernst hismelf experimented with his glow-lamps and with his tubular platinum and iridium furnaces; the air was simply heated and not exposed to electric discharges. The resulting nitric oxide is redecomposed if kept too long in the flame. and has hence to be quickly removed. The investigator has therefore to determine at what temperature and what rate of air-feed an equilibrium can be maintained insuring the maximum yield of nitric oxide."

The first attempt to produce nitrogen compounds in this manner on a commercial scale was that of Bradley and Lovejoy, at Niagara Falls, but this has not yet proved a commercial success.

At the present time interest is given to the process of Birkeland and Eyde, in Sweden, this being based upon the use of flame electrodes of the magnetic blow-pipe type.

"A powerful magnetic field flattens out an arc discharge; with alternating currents a complete flame disk results, with direct currents a half disk. What really happens is, that each little arc is deflected and caused to travel away from the electrodes, until it breaks off; a new arc is at once formed, and thus the disk consists of a series of little arcs in motion which are automatically extinguished. With alternating currents the arcs travel alternately to the right and left, thus producing a flame disk.

"The first communication on the process was made by S. Edstrom at St. Louis in 1904. The experimental furnace then in use worked at Ankerlökken, near Christiania, with arcs consuming up to 200 kilowatts per pair of electrodes, fed with alternating currents of 5,000 volts and 50 cycles. The three furnaces now in operation at Notodden absorb 500 kilowatts each. The furnaces form cylindrical boxes, standing on their edge, or, rather, suspended between two vertical uprights, to the ends of which the coils of the electromagnets are attached. The poles lie in the horizontal axis of the cylinder, and the two perpendicular arc electrodes are at right angles to them. The flame disk of each furnace has a diameter of more than 2 meters. The air enters through ports on both sides of the disk, and is drawn off below, having passed right through the plane of the flame.

"The electrodes are hollow copper rods, rounded off and closed at the ends; water circulates in them, and as the striking points of the arc are constantly being shifted by the magnetic deflection, the wear of the electrodes is inconsiderable. Electrodes have, in fact, been kept in uninterrupted use for hundreds of hours.

"The air leaving the furnace contains not more than 2 per cent. of nitric oxide, and passes first into the reaction or oxidation chambers, in which the gas current is checked in order to cool and to oxidize the nitric oxide to nitric dioxide. That these reaction chambers must have ample dimensions, and that sufficient time must be allowed, is clear from Lepel's researches. The gas is then conducted to eight absorption towers, built up of granite and charged with quartz, in which the gas meets water. The dilute acid flowing off below is again raised, and made to trickle down once more, until the contents of nitric acid have risen to 50 per cent. Two more towers, irrigated with milk of lime, and further, a dry lime chamber, are added to absorb the last traces of acid. The obtained nitric acid is neutralized with limestone, and the calcium nitrate is evaporated and fused with the waste heat of the reaction chambers, and run into iron cases. Among the improvements now under trial is one according to which the nitric dioxide gas is directly passed through the evaporation pans. Any perfection permitting of a more direct method of binding the very dilute gas mixture would, of course, be of the greatest importance, and the technical problems concern the chemist and engineer more than the electrician.

"The average yield is now, at Notodden, from 500 to 600 kilogrammes of nitric acid per kilowatt-year. This statement by the firm is fully borne out by independent tests carried out by several methods, which Prof. Witt conducted on various occasions, and which repeatedly yielded a considerably higher efficiency. There is abundance of available water power. The Tinfos, near by, which is now utilized, can spare 20,000 horse-power; the Svälfos, three miles off, could give 30,000 horse-power; the Rjukanfos, further off, 300,000 horse-power; and it is calculated that the horse-power could be obtained at the exceptionally low rate of 12s. per year. Under these circumstances the good calcium nitrate produced at Notodden could certainly compete with the Chili saltpeter.

LOCOMOTIVE TESTING AT ST. LOUIS.

RESULTS OF TESTS MADE ON THE LOCOMOTIVE TESTING PLANT OF THE PENNSYLVANIA RAILROAD SYSTEM AT THE ST. LOUIS EXHIBITION.

Report of the Testing Staff and Advisory Committee.

At the international exhibition at St. Louis one of the objects of especial interest to the railroad engineer was the locomotive testing plant installed by the Pennsylvania Railroad Company, this being practically a reproduction, with improvements and additions, of the testing plant arranged by Professor Goss several years before at Purdue University. A preliminary report of some of the work of this testing plant has already been issued, and now we have a portly volume, published under the auspices of the Pennsylvania Railroad System, giving a complete description of the whole equipment, and detailed reports of the tests upon eight locomotives, representing the latest types of simple and compound freight and passenger locomotives.

The general arrangement of the locomotive testing plant has already been described in the technical press, and an illustration of the exhibit at the St. Louis exhibition was given in our issue for October, 1904. Briefly, the method consists in placing the locomotive to be tested upon a set of wheels, arranged beneath the drivers in such a manner that the revolutions of the wheels of the locomotive cause the supporting wheels to revolve at the same rate as would be the forward movement of the engine upon the track, the resistance being supplied by dynamometer brakes upon the axes of the supporting wheels. The pull upon the draw bar is measured by a spring dynamometer, while the various operative data, such as indicator diagrams, steam, furnace, and smoke-box temperatures, etc., are readily obtainable, since the engine is stationary, although operating at rates corresponding to full operative speeds upon the road.

During the exhibition eight locomotives were tested, these including American, French and German engines, both simple and compound, for freight and passenger service. These tests were made to show the performance of both engines and boilers, both at average and maximum conditions, and some very interesting results were obtained.

Perhaps no better indication of the results of the tests can be given than by publishing the summary of conclusions accompanying the report, including the performances of both boilers and engines.

"Contrary to a common assumption the results show that when forced to maximum power, the large boilers delivered as much steam per unit area of heating surface as the small ones. At maximum power, a majority of the boilers tested, delivered 12 lbs. (or more) of steam per sq. ft. of heating surface per hour; two delivered more than 14 lb., and one, the second in point of size, delivered 16.3 lb. These values expressed in terms of boiler HP. per sq. ft. of heating surface are 0.34, 0.40 and 0.47, respectively.

The two boilers holding the first and second place with respect to weight of steam delivered per sq. ft. of heating surface are those of passenger locomotives. The quality of steam delivered by the boilers of locomotives under constant conditions of operation is high, varying somewhat with different locomotives and with changes in the amount of power developed, between the limits of 98.3 per cent. and 99.0 per cent.

The evaporative efficiency is generally maximum when the power delivered is least. Under conditions of maximum efficiency, most of the boilers tested evaporated between 10 and 12 lb. of water per lb. of dry coal. The efficiency falls as the rate of evaporation increases. When the power developed is greatest, its value commonly lies between limits of 6 and 8 lb. of water per lb. of dry coal.

The observed temperature of the fire-box under low rates of combustion lies between the limits of 1,400° F. and 2,000° F., depending apparently upon characteristics of the locomotive. As the rate of combustion is increased, the temperature slowly increases, maximum values generally lying between the limits of 2,100° and 2,300° F. The smokebox temperature for all boilers, when worked at light power, is not far from 500° F. As the power is increased, the temperature rises, the maximum value depending upon the extent to which the boiler is forced. For the locomotives tested, it lies in most cases between 600 and 700°.

With reference to grate area, the results prove beyond question that the furnace losses due to excess air are not increased by increasing the area. In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of greatest capacity. A brick arch in the fire-box results in some increase in furnace temperature and improves the combustion of the gases. The loss of heat through imperfect combustion is in most cases small, except as represented by the discharge from the stack of solid particles of fuel. Relatively large firebox heating surface appears to give no advantage either with reference to capacity or efficiency. The fact seems to be that the tube heating surface is capable of absorbing such heat as may not be taken up by the firebox.

The indicated horse-power of the modern somple freight locomotive tested may be as great as 1,000 or 1,100; that of a modern compound passenger locomotive may exceed 1,600 horse power. The maximum indicated horse power per square foot of grate surface lies, for the freight locomotives, between the limits of 31.2 and 21.1 horse power for the passenger locomotives, between 33.5 and 28.1 horse power.

The steam consumption per indicated horse power necessarily depends upon the conditions of speed and cut-off. For the simple freight locomotives tested the average minimum is 23.7. The consumption when developing maximum power is 23.8 and when under those conditions which proved to be the least efficient, 29.0. The compound locomotives tested, using saturated steam, consumed from 18.6 to 27 pounds of steam per indicated horse power hour. Aided by a superheater, the minimum consumption is reduced to 16.6 pounds of superheated steam per hour.

In general the steam consumption of simple locomotives decreases with increase of speed, while that of the compound locomotives increase. From this statement it appears that the relative advantages to be derived from the use of the compound diminish as the speed is increased.

The percentage of the cylinder power which appears as a stress in the drawbar, diminishes with increase of speed. At 40 revolutions per minute, the maximum is 94 and the minimum 77; at 280 revolutions per minute, the maximum is 87 and the minimum 62.

The loss of power between the cylinder and drawbar is generally affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

The coal consumption per dynamometer horse power-hour for the simple freight locomotives tested, is at low speeds not less than 3.5 pounds nor more than 4.5 pounds, the value varying with runing conditions. At the highest speeds covered by the tests, the coal consumption for the simple locomotives increased to more than 5 pounds. The coal consumption per dynamometer horse power-hour for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 pounds. Results at higher speeds were obtained only from a two-cylinder compound, the efficiency of which under all conditions is shown to be very high. The coal consumption per dynamometer horse- power-hour for this locomotive at the higher speeds increases from 3.2 to 3.6 pounds. The coal consumption per dynamometer horse power-hour, for the four compound pasenger locomotives tested, varies from 2.2 to more than 5 pounds per hour, depending upon the running conditions. In the case of all of these locomotives, the consumption increases rapidly as the speed is increased.

A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the drawbar, the poorest compound shows a saving in coal over the best simple which will average above 10 per cent., while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period covered by the observations, are. all favorable to the compound.

It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse-power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant. It is worthy of mention that the coal consumption per horse power hour developed at the drawbar by the different locomotives tested presents marked differences. Some of these are easily explained from a consideration of the characteristics of the locomotives involved. Where the data are not sufficient to permit the assignment of a definite cause, there can be no doubt but that an extension of the study already made will serve to reveal it."

ELECTRIC DRIVING OF MACHINE TOOLS.

A STUDY OF THE RELATION OF ELECTRIC DRIVING TO THE GENERAL ECONOMY OF MACHINE-SHOP OPERATION.

E. R. Douglas—Electrical Review.

ENGINEERS and works managers are beginning to realize that there is little use in considering operative advantages and economies in detail unless these can be shown also to have a favorable effect upon the performance of the entire plant. This is no new idea, but apparently it has to be learned over and over again. It is not necessary that an engine should show an economy in steam provided it can show a saving in money, and there is little use in putting in a high priced machine tool, of certified high efficiency, unless the conditions are such that it can be maintained in operation continuously. It is an old saying that valuable horses kept in the stable are very successful in "eating their heads off," and this performance is not limited to horses, but may be applied to some mechanical installations as well. At the same time it is found that appliances which may not be economical in the sense that their advocates desire to impress may be found advantageous in other respects, and among such subjects may be included the electric motor, when set at the uncertain task of driving machine tools. In an article in a recent issue of the *Electrical Review* there is an instructive paper by Mr. E. R. Douglas upon the economy of electric driving in the machine shop, from which we make some abstracts.

"A few years ago the question of motor driving was considered entirely on the basis of saving in power. Much ingenuity was spent in computing power losses in line shafting, belts and countershafts and in determining the precise points where saving in power was offset by increased investment charges. It is undeniable that the loss in transmitting power electrically, except over short distances, is less than with mechanical transmission, especially as the amounts of power become large; and, when the driven units are few and large, the first cost of motors and wiring may be no greater than the cost of shafting and hangers. The motor-drive problem then becomes comparatively simple.

"But witb greater subdivision and smaller absorbing units the first cost is increased enormously. Not only are small motors relatively more expensive than large ones, but the number of motors standing idle or running lightly loaded at any time is greater. The total motor capacity for the plant is therefore much increased, even three, four, or five times. For these reasons applications of motors to the driving of factories were at first confined to the class known as 'group driving, in which a few good-sized motors drive independent short lengths of line shafting to each of which a group of machines is connected by means of belts and countershafts.

"When electric motors began to be used in machine shop driving it was soon found that there were other advantages besides those of power economy to be considered. The removal of belts gave better lighting and greater flexibility in the arrangement of tools, the line-shaft being no longer the main criterion in the placing of machines. By placing tools in the natural order of the progress of the work, and by utilizing the space to the best advantage it was found that dollars in time might be saved even when there was no appreciable gain in power cost. There is always an advantage in being able to cut off the use of power when a machine is thrown out of operation, but in any case it should be remembered that the cost of power is only about two per cent. of the total cost of manufacture, while labor reaches from thirty to fifty per cent., so that anything which enables the work of the mechanic to be utilized to better advantage should be given first consideration.

"It will be seen that the argument for motor driving has tended, from its first position where cost of power was alone considered, toward one in which comfort, convenience and general economy are more important. There is a dollars and cents argument for this. Men work better and do more when they are comfortable, when light and ventilation are good. Convenience means minimizing of delay and more rapid production. There is often a greater saving from the entire elimination of small losses than from trifling reductions on the larger items of expense.

"But with all these advantages motor driving of factories proceeded for a number of years at only a moderate pace. The electrical companies worked for what they got and were often met with apathy or even determined opposition. It required a combination of two great improvements, directly affecting production, to bring about a change. These were the introduction of high-speed steel for cutting tools and the development of commercially practical variable-speed motors. With these came an appreciation of the importance of the labor element in manufacturing operations and certain carefully worked out systems for determining that and other elements of cost."

With the introduction of electrical driving of machine tools came also the high-speed tool steels, and these steels need above everything else a proper control over the cutting speeds on the work. An increase of the linear speed of the work before the point of the tool from two to four times that which had hitherto been possible, came into the shop about the same time that the electric motor appeared on the field, and naturally both elements demanded consideration together.

"In the upheaval caused by these steels much that was obsolete beside cutting speeds was brought to light. When it was attempted to use such steels at their highest speeds on machine tools of ordinary designs, those tools speedily developed structural weaknesses, made apparent by breaking down or by excessive vibration. The general line of metal-working machinery has had to be largely redesigned, not only made heavier, but changed entirely in important details in order that the machinist may avail himself of the highest speeds now possible.

"It would also seem that even the steels formerly standard were not, except in a very few cases, used up to their limit of capacity, this owing to lack of knowledge on the part of the workman as to what he could do, lack of attention on the part of the foreman, if he had the knowledge, and general indifference to the details of rapid production. The advent of the new steels called attention to this laxness and to the need of taking complete advantage of the new situation. If a tool steel, which, under given conditions could cut at 100 feet a minute, were actually used at only eighty feet, the time of machining would thereby be increased twenty-five per cent., a margin well worth saving."

With the old belt driven tools the number of speed changes was necessarily limited, and often a mistake was made in endeavoring to use a speed too high, because the next lower speed was lower than was really desired.

At first the electric motor failed also to meet the requirements of speed changes, but this problem has been attacked by a number of designers, and now a variety of speed-changing systems are in the field.

"The commercially successful system of motor-speed control may be grouped under three classes: two-wire system, three-wire systems and four-wire systems.

"The two-wire systems make use of a single voltage and a motor capable of large speed variations by field regulation. Until recently it was not found practical to make a variation in speed of more than thirty per cent. in this manner, as the tendency of the motor to spark became excessive at the higher speeds and weak fields. Improvements in motors now permit of speed ranges of 2 : 1 or 3 : 1, and in the case of certain very special motors as much as 6 : 1, with fairly satisfactory results. The sizes of motors required for these large ranges become, however, very great as compared with the size of constant-speed motors of the same output, or even as compared with variable-speed motors on the three or four-wire systems. The two-wire system is one, nevertheless, of great promise for situations where the others are not deemed advisable.

"The most common three-wire system makes use of 230 volts between mains and 115 volts between each main and neutral. This gives two speeds directly on the voltages. The increase by field regulation necessary to bridge the gap between them is nearly 100 per cent. and the same increase is usually made above the 230-volt speed as well. The total range then becomes 4 : 1. The three-wire system is also used with uneven voltages, as, for instance, seventy-seven and 153, respectively, between the neutral and the outside wires, the main voltage being 230. Then 100 per cent. increase by field regulation is necessary above seventy-seven volts and fifty per cent. above 153 volts. If 100 per cent. can be used above 230 volts, a 6 : 1 range is obtained. With fifty per cent. above 230 volts the range becomes 4.5 : 1.

Mr. Douglas gives a number of examples of the speed changes obtainable in lathe work by a combination of motor changes and change-gears, with charts showing the power consumed for work of various diameters. A practical example of turning on a forged shaft with plate coupling is given, with the times required for carrying out the work under ideal and under practical conditions. It is shown that, under average conditions, the practical gain due to better control of speeds, a saving of more than 35 per cent. in the labor cost would result from the use of the electric motor over belt driving.

There is little doubt that electric driving possesses many advantages, but the manager who attempts to make a decision solely upon the point of power saving is very apt to be deceived. The question should be considered upon its merits, taking into account the operative conditions actually existing in the shop under consideration, remembering always that the great point is to keep down the labor-cost of the product, and that, not by reducing the rate per man, but by increasing the output, so as to diminish the relative expense burden as well as the direct labor-cost.

AUTOMOBILE-VEHICLE DEVELOPMENT.

THE INFLUENCE OF THE DEVELOPMENT OF THE MECHANICALLY-PROPELLED VEHICLE UPON SOCIAL AND COMMERCIAL INTERESTS.

Claude Johnson—Journal of the Society of Arts.

WE have had numerous papers devoted to the description of various types of automobile vehicles, and others discussing structural details, fuels, manufacturing methods and the like, all of which are interesting and appropriate in the course of the development of a great industry. The broad subject of the growth of the mechanically-propelled vehicle, its influence as a substitute for animal traction, its relation to the commercial and personal life of the community—these are also questions which demand the attention of the engineer; and these and related subjects form the substance of an address recently delivered by Mr. Claude Johnson before the Society of Arts, and published in the *Journal* of the society.

After a brief reference to the extent to which antiquated legislation prevented the early development of mechanical vehicles in Great Britain, Mr. Johnson gives an historical resume of the growth of the automobile industry, from the fundamental work of Daimler in Germany to the later efforts of the French constructors, and then takes up the detailed development year by year from 1895, and the enactment of legislation permitting the use of motor vehicles on roads in the United Kingdom.

From this point the history of automobile development is mainly one of mechanics and engineering. France, having had no legal restrictions to impede the work, naturally gained a good lead, and with the opening of the Automobile Club de France in 1896, following the Paris-Bordeaux race, and the exposition at the Palais d'Industrie of the preceding year, the automobile interest really began in earnest.

At first the interest centred in speed trials, and the Paris-Marseilles race of 1896, over a distance of 1,076 miles was the beginning of a series of trials which undoubtedly did much to develop the motor car. This was followed by numerous exhibitions, races and competitions, which Mr. Johnson describes with some detail, extending down to the close of 1905. It is interesting to note that in the original Paris-Marseilles race of 1895 the average speed of the winner was 15.6 miles, while in the Vanderbilt cup race in America in 1905 there was covered a distance of 198 miles at an average speed of 69.9 miles per hour.

Mr. Johnson has prepared for publication a chart showing the distance over which the famous motor races were run, and the average speed attained by the wining cars. This chart shows the average speed in 1894 as 12 miles an hour, and the average speed in 1903 as 62.5 miles per hour.

"The subject of motor racing cannot be left without refering to the undoubted benefit which long distance racing was to the motor industry. The keen contests which took place between maker and maker and between nation and nation, have resulted in its being discovered by constructors that cars can, by the use of the very best material, be constructed within weight limits, which would not have been admitted as theoretically possible by consulting engineers ten years ago. Since 1901, however, there has been a feeling that the time would come when the racing of purely racing machines would cease to be of particular advantage in the design and construction of touring cars. The Automobile Club of Great Britain therefore started last year a new form of racing for what is called the Tourist Trophy, in which the cars have to me *bonâ-fide* touring cars, affording a certain amount of seating capacity, and carrying four passengers or their equivalent weight on *chassis* of not less than a certain weight. The speed of the cars is limited by the fuel allowance, the same quantity of fuel being given to all the competing cars. The car which completes the distance in the shortest time, that is, the car which can most efficiently transmit the power obtained from the motor to the road wheels, and can cover the distance without running out of petrol and without delay, is the car which wins. It is thought by many experts that this new form of racing is likely to considerably improve the construction and design of touring cars, inasmuch as it compels makers to study the question of efficiency rather than to obtain speed out of their cars by means of engines which are unnecessarily large in order to overcome the inefficiency of transmission."

In most of the development of the high-speed motor car the honors went to Continental builders, but with the formation of the Liverpool Self-Propelled Traffic Association came the excellent work done by that body in promoting the construction of vehicles for heavy traffic. The efforts of such men as Professor Hele-Shaw, Mr. E. Shrapnell Smith, Sir Boverton Redwood, and others, have resulted in the development of an industry of importance which is destined to work a revolution in the design of heavy mechanically propelled vehicles.

Mr. Johnson reviews successive the subjects of legislation, automobile associations, technical and trade publications devoted to automobilism, and the position which automobilism has taken in the social and industrial worlds, and concludes with a resume of the growth of the industry as a whole.

"Six years ago the writer spent many hours in watching on the big highways leading out of London for passing motor-cars without seeing one, and if he did see one, he could at once recognise the owner and make of the car. Now one can scarcely cross the road without having to run to avoid a motor-car, and the makes of cars are so numerous that it is difficult to identify them.

"Twelve years ago the average speed of a racing car over a long distance was 12 miles an hour. To-day, the average long distance speed is 69 miles an hour. Eight years ago there were 163 members of the Automobile Club. Now there are 2,860.

"Seven years ago one was regarded as insane if one drove a motor. Now one is regarded as insane if one does not drive one.

"Two years ago a motor-omnibus was regarded as a curiosity. To-day there are 260 running in London. Seven years ago there were only a few people who drove motors. Now there are so many drivers of motors that the receipts of the railway companies have been seriously affected.

"Seven years ago, at the Richmond Show, there was only one 4-cylinder motor, now nearly all motor cars, except the lighter and cheaper classes are fitted with 4-cylinder motors, except those with the 6-cylinder motor, which were first introduced by Messrs. Napier and Edge three years ago, and those fitted with 8-cylinders. The 6-cylinder motor is without doubt gaining ground, seeing that one crank-shaft maker alone in this country is making 6-cylinder crank shafts for 13 firms. Mr. Edge's 6-cylinder car held the world's record for speed last year. The 8-cylinder motor V type, which is built by Levassor and was used in motor-boats last year, has been adopted by the company in which the writer is commercially interested, in motor-cars, the first cars fitted with one being shown at the last exhibition at Olympia, and the 8-cylinder "V" motor has since then been adopted by the Darracq Company on their racing car, with which they have attained the speed of 122½ miles an hour. Seven years ago, although Benz, Mors, and others were using and had always used electric ignition, Panhard and Daimler were still using tube ignition, and the only magneto shown was that fitted to Mr. Simms' motor cycle. To-day tube ignition has been abandoned, and the magneto is rapidly taking the place of electric ignition.

"Ten years ago the *Daily Telegraph* thought that we were not within measurable distance of the day on which the people in society would use electric carriages for town work. Six years after this wise announcement most of the leaders of London society were using electric carriages, and to-day there are said to be 500 electric carriages in use. Seven years ago at the Richmond exhibition there were 130 motor-cars and commercial vehicles, and 16 motor-cycles exhibited. Last November at Olympia, there were 496 vehicles shown, of which 56 per cent. were British vehicles, 93 per cent. were petrol, 4 per cent. steam, and 3 per cent. electricity. Seven years ago a motor exhibition involved a loss of £1,600: now a motor exhibition means a profit of many thousand pounds.

"Seven years ago the annual output of cars of the motor companies in this country could be counted in scores. This year the Daimler Company—which last year made a profit of £80,000—hopes to turn out over

1,000 *chassis;* the Argyle Company hopes to manufatcure 1,500 complete cars this year; the Napier Company claim to be turning out *chassis* having a selling value of half-a-million pounds per annum; and the Wolseley Company employ 2,000 men, and have a wages-bill of more than £150,000 per annum. Probably the salaries and wages paid in this kingdom in the motor industry amount to £1,500,000 per annum, and the turnover to £5.500,000."

These figures relate solely to the development of the automobile industry in Great Britain, and show the extent of the new industries and new sources of wealth which the work of the engineer has created in a single line of work, not by diverting capital and labour from other departments of industry, but by giving new occupation to men and money. If, to this notable showing, there is added the still greater development of the same industry on the Continent and in the United States it will be seen to how great a degree mechanical invention and engineering enterprise may add to national wealth.

LOCOMOTIVE BOILERS.

NOTES ON THE DESIGN AND OPERATION OF LOCOMOTIVE BOILERS, WITH ESPECIAL REFERENCE TO THE INCREASE IN SIZE AND THE LIMITATIONS OF DIMENSIONS.

G. J. Churchward—Institution of Mechanical Engineers.

WE have reviewed elsewhere in this issue the valuable results of the locomotive testing plant of the Pennsylvania Railroad Company at the St. Louis exposition, and as a fitting complement to those experimental investigations we may note the paper of Mr. G. J. Churchward, the locomotive superintendent of the Great Western Railway, upon the subject of large locomotive boilers, presented at a recent meeting of the Institution of Mechanical Engineers:

"The modern locomotive question is principally a question of boiler. The great increase in the size of boilers, and in the pressures carried, which has taken place during the past few years has necessitated the reconsideration of the principles of design which have been worked out and settled during many years' experience with comparatively small boilers carrying low pressures. The higher temperatures incidental to the higher pressures have required the provision of much more liberal water spaces and better provision for circulation. Locomotive engineers have now apparently settled down to the use of one of two types of boiler for very large engines —the wide fire-box extending over the frames and wheels, and the long narrow box sloping up over the axles behind the main drivers."

In the United States the wide fire-box has been extensively employed, the larger grate area enabling inferior fuels to be burned, or, with better grade fuel enabling a greater steaming capacity to be secured. In Great Britain the narrower loading gauge, due to the smaller space between tracks, and the closer clearance at platforms, tunnels, bridges, etc., prevents the with the wide fire-box, and discusses the over the wheels, and the narrow box is necessarily employed.

Mr. Churchward refers to the difficulties experienced with leaky tubes in connection with the wide fire box, and discusses the possible remedies.

"All methods of tube-expanding have been tried, and also much wider spacing, even up to and over 1 in., without curing the trouble. The reduction of the depth of the fire-box, in order to get a long box sloping over the trailing-wheels of coupled engines, certainly increased the trouble from leakage of stays; but the alternative of a wide fire-box entails a much heavier engine for most of the types, and then apparently tube trouble is increased. The wide fire-box evidently requires a higher standard of skill in the fireman, for unless the grate is kept well and evenly covered, there is a tendency to have an excess of air, reducing efficiency and increasing tube trouble. With modern high pressures the temperature of evaporation is so much increased that the provision for circulation which was sufficient for the lower pressures formerly used is doubtless insufficient. Boilers in which this provision has been made have shown a very marked reduction in tube and stay troubles.

"It is probable that in the wider boxes the main mass of the fire being so much nearer the tube-plate has a bad effect on the tubes, as the intensity of the temperature at the tube-plate must necessarily be much increased. The extra width of the box has enabled the tubes to be put much too near the sides of the barrel. When this is done, the water to feed up the spaces between the tubes near the back tube-plate has to be drawn almost entirely from the front of the barrel; and it is possible that in some cases the space left for this purpose is inadequate. It will probably be found that neglect of this consideration is the cause of three-fourths of the tube trouble. In some boilers, an effort has been made to provide for this upward circulation near the back tube-plate by leaving a space between the tubes and barrel, from top to bottom, of a sectional area equal to the combined area of the vertical spaces between the tubes at all points, with a balance to provide for the water coming back from the front of the barrel to feed the water-spaces of the fire-box."

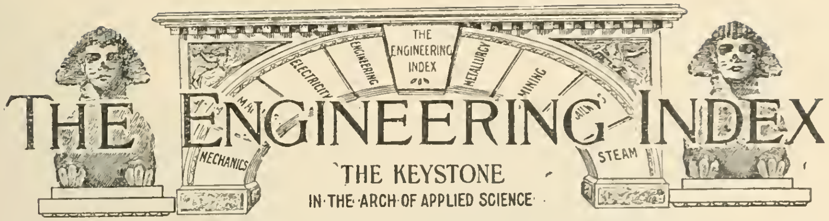
There is no doubt that the circulation of the water is an important element in the satisfactory performance of a boiler which is driven at the rate necessary in modern locomotive service. The nature and direction of the circulation is naturally dependent to a great extent upon the firing, and experiments have shown that a change in the firing will have a marked effect upon the circulation, even to the extent of entirely reversing the direction of the currents.

"The ratio of diameter to length of the tube undoubtedly has a most important bearing upon the steaming qualities of the boiler, and upon the efficiency of the heat absorption. This is more particularly noticeable when the boilers are being worked to the limit of their capacity. If 2-in. tubes, say, are employed in barrels 11 ft. to 12 ft. long, when the boiler is being forced the length is not sufficient to absorb the heat from the amount of gases that a 2-in. tube will pass, and overheating and waste result. The amount of tube-leaking which is experienced with modern wide boxes in America has brought up again the idea that the spacing should be wider—say, 1 in. instead of ¾ in.; but, from the investigations of a Master Mechanics' Committee, it appears that the wider spacing does not cure the trouble. It is clearly of no use to provide wider spaces for the upward current unless equivalent area is provided for the downcoming water.

"The gradual extension of the practice of making the top of the fire-box and casing flat, instead of round, is noticeable. On the Great Western Railway less trouble has been experienced with the flat-top fire-box than with the round-top, although no sling-stays of any kind are used. The flat-top has the important advantage of increasing the area of the waterline at the hottest part of the boiler, and so materially contributes to the reduction of foaming. This, combined with the coned connection to the barrel, has enabled the dome, always a source of weakness, to be entirely dispensed with and drier steam obtained. The liberal dimension of 2 ft. between the top of the fire-box and the inside of the casing no doubt contributed to the satisfactory result. The coned barrel connection, in addition to providing a greater area of water line, also gives a larger steam capacity, and, by the larger diameter being arranged to coincide with the line of the fire-box tube-plate, much more water space at the sides of the tubes is possible. On consideration of the great intensity of temperature at the fire-box plate, as compared with that at the smoke-box plate, the advantage of the arrangement is obvious."

An interesting point brought out by Mr. Churchward is the extent to which superheating may permit a reduction in boiler pressures to be made. It is understood that high pressures are necessary in order to enable the full benefits of compounding to be secured, but it is believed that by the introduction of the superheater a similar gain may be had, and at the same time the boiler pressure lowered from 225 pounds to 175 pounds per square inch, a fact which would aid materially in solving certain boiler troubles.

Mr. Churchward gives in his paper a series of illustrations of large locomotive boilers representing recent American and British practice, together with details of shell and fire-box construction.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

City Bridges.

Urban Bridges. Willis Whited. Discusses points in connection with the design and construction of city bridges, as distinguished from railroad bridges and highway bridges. Also discussion. 6500 w. Pro Engrs' Soc of W Penn—Feb., 1906. No. 75091 D.

Girders.

Girder Renewals, N. W. R., India. G. H. List. Illustrated account of heavy girder renewals under traffic on a single line. 800 w. Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75069 A.

Iron Bridges.

Buildwas Bridge. An interesting account of the first two iron bridges of the world, built in the Severn valley; with special description and illustrations of this bridge built in 1796, and now being demolished, and to be replaced by a bowstring lattice girder structure of the same span. 1500 w. Engr, Lond—Feb. 2, 1906. No. 75000 A.

Missouri River.

New Bismarck Bridge of the Northern Pacific. Illustrated description of a new bridge in North Dakota, built to replace one too light for present traffic. 800 w. R R Gaz—Vol. XI, No. 8. No. 75238.

Reconstruction of the Bismarck Bridge. Illustrated detailed description of the method of construction of a single-track bridge on the Northern Pacific Railway. 2500 w. Eng Rec—Feb. 24, 1906. No. 75264.

New York.

Erection of Falsework and Pier Pedestals, Island Span, Blackwell's Island Bridge. Illustrated description. 1400 w. Eng Rec—Feb. 24, 1906. No. 75260.

Secondary Members of the Island Span of the Blackwell's Island Bridge, New York. Illustrates and describes the design. 1600 w. Eng Rec—Feb. 10, 1906. No. 74976.

Reinforced Concrete.

The Pollasky Reinforced Concrete Bridge. Illustrated description of a recently completed bridge in California, which is one of the largest reinforced concrete bridges in the country. 1000 w. Eng Rec—Feb. 24, 1906. No. 75263.

Suspension.

The Elizabeth Eye-Bar Suspension Bridge at Budapest. Leon Ramakers. A handsomely illustrated description of the new bridge across the Danube at Budapest, with details of the erection and of the manufacture of the eye bars. 2500 w. Engineering Magazine—March, 1906. No. 75165 B.

CONSTRUCTION.

Chimneys.

A 350-Ft. Brick Chimney for Acid Chemical Gases. Theodore Lindeman. A brick chimney of unusual height recently completed at Newark, N. J., is illustrated and described in detail. 1800 w. Eng News—Feb. 15, 1906. No. 75016.

Recent American Chimney Practice. William Wallace Christie. An illustrated article considering types of chimneys for industrial purposes recently built. 2300 w. Cassier's Mag—Feb., 1906. No. 74-918 B.

Concrete.

Concrete Buildings in the United States. An illustrated detailed description of the applications of concrete to building construction, with the use of monolithic construction, and of concrete building blocks. 2000 w. Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75067 A.

Concrete Mixers. J. S. Owens. Read before the Civ. & Mech. Engrs. Soc. Illustrates and describes various machines that have been devised, discussing the methods in use. 5000 w. Engng—Feb. 9, 1906. No. 75077 A.

Practical Notes on Concrete Building Construction. C. A. P. Turner. Abstract of a paper read before the Nat. Assn. of Cement Users. Remarks on materials and the reliability of the construction as compared with steel or timber, giving information from the writer's experience. 2700 w. Eng News—Feb. 1, 1906. No. 74808.

Concrete Blocks.

Causes of Failures in the Concrete Block Business. O. U. Miracle. Read at Con. of Nat. Assn. of Cement Users. Discusses the most serious dangers that seem to threaten this industry. 2500 w. Munic Engng—Feb., 1906. No. 75219 C.

The Selection of Portland Cement for Concrete Blocks. Richard K. Meade. Read before the Nat. Assn. of Cement Users. Points out the properties most requisite in Portland cement to be used for the manufacture of concrete blocks. 4500 w. Eng Rec—Feb. 10, 1906. No. 74975.

Waterproofing. J. L. Mothershead, Jr. Read at Con. of Nat. Assn. of Cement Users. Considers the waterproofing of concrete blocks. 1200 w. Munic Engng—Feb., 1906. No. 75217 C.

Excavation.

Difficult Excavation on the Hennepin Canal. An illustrated description of difficult work being executed by the U. S. Government on the Illinois and Mississippi ship canal. A Lidgerwood duplex traveling cableway of special design is used. 1200 w. Eng Rec—Feb. 10, 1906. No. 74973.

Fireproof.

Concrete and Hollow Tile. E. A. Trego. Illustrates and describes an example of the combined use of reinforced concrete and tile in fireproof construction. 1600 w. Cement Age—Feb., 1906. No. 75211.

Paper on Fireproof Construction. Owen Brainard. Read before the Ontario Assn. of Archts. Discusses the protection of steel skeleton buildings from both exterior and interior fires. 5800 w. Can Archt—Jan., 1906. No. 74927 C.

Floors.

Fire and Water Tests of Stone-Concrete and Cinder-Concrete Floors Reinforced with Corrugated Bars. Gives drawings of two forms of reinforced concrete floors, with report of tests made and the effects. 700 w. Eng News—Feb. 1, 1906. No. 74804.

I. Fire Test of a Concrete Floor with Bays of Different Aggregates. II. The Resistance of Cement and Concrete Construction to Fire. Two papers discussed together editorially. The first is an abstract of report on experimental fire test made by the British Fire Prevention Committee. The second an abstract of a report presented at meeting of the Nat. Assn. of Cement Users. 6800 w. Eng News—Feb. 1, 1906. No. 74805.

Foundations.

Modern Foundation Construction with Concrete Piles (Ueber Neuere Fundierungsmethoden mit Betonpfählen). K. E. Hilgard. An illustrated description of the various systems of making and driving piles of reinforced concrete, showing the superiority of such foundations to wooden piles. Serial. Part I. 2000 w. Schweiz Bauzeitung—Jan. 20, 1906. No. 75125 B.

Piles.

Concrete Piles. David Lay. Illustrated description of the methods of manufacture and use of two leading types of concrete piles which are replacing wooden piles. 1800 w. Cement Age—Feb., 1906. No. 75212.

Manufacture and Use of Concrete Piles. Henry Longcope. Read at Con. of Nat. Assn. of Cement Users. Reviews the methods of pile construction tried at various times, especially the use of concrete. 2500 w. Munic Engng—Feb., 1906. No. 75218 C.

Reinforced Concrete.

Notes on Reinforced Concrete for Columns. James E. Howard. Considers the method of reinforcing by hooping, and the method of reinforcing by longitudinal bars, and their advantages. 2000 w. Eng Rec—Feb. 10, 1906. No. 74978.

Notes on the Friction of Iron Reinforcements in Beams (Beitrag zur Bestimmung des Gleitwiderstandes bei Balken aus Eisenbeton). G. Ramisch. A mathematical examination of the relation of the frictional resistance of reinforcing rods to the shearing resistance of the concrete, in beams reinforced with plain round or flat rods. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 26, 1906. No. 75123 D.

Reinforced Concrete on the Pacific Coast. H. A. Crafts. Brief illustrated description of the construction of a concrete and steel paper-mill building at Oregon City, Oregon. 1000 w. Sci Am—Feb. 24, 1906. No. 75084.

Steel for Reinforcement. A. L. Johnson. Read at Con. of Nat. Assn. of Cement Users. Discusses the resistance of the bars, some things tending to impair the bond, and fundamental principles. 2300 w. Munic Engng—Feb., 1906. No. 75214 C.

Stone Masonry.

Decay of Stone Masonry. J. W. Dougal, in the Glasgow *Herald.* Considers some causes of decay other than those best known, and the prevention. 1200 w. Ry & Engng Rev—Feb. 17, 1906. No. 75042.

Tunnels.

Construction of a Subway Tunnel Under the River Seine in Paris. E. Ommelange. Illustrated description of the construction of a single-tube, double-track tunnel, at an estimated cost of $3,100,000. 1400 w. R R Gaz—Vol. XL, No. 7. No. 75025.

The Detroit River Tunnel of the Michigan Central. Map and illustrated detailed description of the proposed railroad tunnel. Four methods are included in the specifications, any one of which may be used. 3000 w. R R Gaz—Vol. XL, No. 7. Serial. 1st part. No. 75021.

The Proposed Tunnel Under the Detroit River for the Michigan Central R. R. An illustrated description of plans worked out for this railroad tunnel, any one of which may be taken by bidders, or he may present plans of his own. 4000 w. Eng News—Feb. 15, 1906. No. 75019.

The Remarkable Tunnel Crossing of the Seine by Line 4, Metropolitan Railway of Paris. Brief illustrated description of tunnel formed of sections constructed as caissons and sunk end to end to grade. 1200 w. Eng News—Feb. 15, 1906. No. 75018.

MATERIALS OF CONSTRUCTION.

Bricks.

The Manufacture of Silico-Calcareous Bricks (Fabrication des Briques Silico-Calcaires). A description of the Röhrig and König process, with plan of works for the manufacture. The bricks have a high crushing strength and resistance to fire. 1200 w. 1 plate. Génie Civil—Jan. 27, 1906. No. 75113 D.

Cement.

A Large Portland Cement Plant at Bath, Pa. W. G. Tatnall. Illustrated detailed description of a plant designed for 2500 barrels output per day. 3000 w. Engr, U S A—Feb. 1, 1906. No. 74850 C.

Cement and Building Construction. C. A. P. Turner. Read at Con. of Nat. Cement Users. Discusses the importance of good workmanship in the use of this material, giving points that should secure good results. 2800 w. Munic Engng—Feb., 1906. No. 75215 C.

Flame Regulation in Cement Burning. Carleton Ellis. Discusses methods of cement burning and the causes of imperfect calcination. 2000 w. Cement Age—Feb., 1906. No. 75213.

The Testing and Use of Portland and Natural Cements. E. S. Larned. Read before the Nat. Assn. of Cement Users. Gives an expert's views, with details and results of experiments. 4300 w. Munic Jour & Engr—Feb. 7, 1906. No. 75006.

The Use of Cement for Farm Purposes. S. M. Woodward. Read at Con. of Nat. Assn. of Cement Users. Suggests some uses to which cement is applicable. 2000 w. Munic Engng—Feb., 1906. No. 75216 C.

Plaster.

Plaster Mining and Preparation in the Vicinity of Paris. Jacques Boyer. A fully illustrated account of the quarrying of the gypsum, and the practical operations of calcining and grinding plaster as conducted near Paris. 2500 w. Engineering Magazine—March, 1906. No. 75164 B.

Timber.

Experience in Creosoting Douglas Fir. P. F. Dundon. Extract from a paper read before the Wood Preservers' Assn. Gives the writer's experience with "Oregon pine," and timbers of the Pacific Coast. 600 w. Eng News—Feb. 8, 1906. No. 74917.

Recent Progress in the Protection of Structural Timber from Organisms of Decay (Neuere Ergebnisse in der Bekämpfung der im Hochbaue Auftretenden Holzzerstörenden Pilze). Basilius Malenkovic. Giving a list of the latest antiseptic preparations for the prevention of decay in timber, and a bibliography of recent writings on the subject. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1906. No. 75127 D.

MEASUREMENT.

Surveying.

Pathfinding for Canada's New Transcontinental Railway. H. V. Ross. Deals with the work of survey between Winnipeg and Moncton; which is to be built by the Dominion Government at an estimated cost of $100,000,000. Ills. 5500 w. Eng News—Feb. 1. 1906. No. 74803.

Public Land Surveys by Government Engineers in Indian Territory. Charles H. Fitch. A record of work done in 1895 in the survey and subdivision of nearly 31,000 square miles of land. 1200 w. Eng News—Feb. 8, 1906. No. 74916.

Stadia in Careful Work. Alfred H. Webb. Describes methods used by the writer, discussing variations in practice. 2000 w. Min Rept—Feb. 1, 1906. No. 74834.

MUNICIPAL.

Incinerating Plant.

The New York Rubbish Incinerating Plant. S. D. V. Burr. Illustrated detailed description of this plant, which is utilized in lighting the Williamsburgh Bridge. 2000 w. Ir Age—Feb. 8, 1906. No. 74904.

Pavements.

The Construction of Pavements in Chicago. Abstract of a paper by J. A. Moore, read before the Illinois Soc. of Engrs. & Survs. An explanation of the actual construction work; considers lines and grades, foundations, granite block, brick, asphalt, macadam, etc. 3500 w. Eng Rec —Feb. 3, 1906. No. 74863.

Refuse.

The Utilization of Refuse by Triple Sorting (Müllverwertung, Insbesondere nach dem Dreiteilungsverfahren). Dr. Hans Thiesing. A discussion of the refuse disposal problem, showing the advantages of a careful separation of the ashes, organic matter, and utilisable material from refuse, passing the second only to the destructor. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 19, 1906. No. 75122 D.

Sewage Disposal.

Combined Septic Tanks, Contact Beds, Intermittent Filters and Garbage Crematory, Marion, O. R. Winthrop Pratt. Illustrated detailed description of the sewage disposal plant and the garbage and refuse crematory. 5000 w. Eng News—Feb. 22, 1906. No. 75245.

The Sewage Disposal Plant at Downers Grove, Ill. W. S. Shields. Read before the Illinois Soc. of Engrs. & Survs. Illustrated description of a system of sand filtration following a septic treatment. 1600 w. Eng Rec—Feb. 3, 1906. No. 74865.

Waste.

The Disposal of Municipal Waste. William F. Morse. The first of a series of articles to appear monthly. Deals with systems and methods, with special reference to American conditions. 4500 w. Munic Jour & Engr—Feb. 7, 1906. Serial. 1st part. No. 75005.

WATER SUPPLY.

Filtration.

Construction and Operative Costs of the Sand Filters of the Amsterdam Waterworks (Constructie der Filters en Kosten van Zandfiltratie op het Pompstation Leiduin der Amsterdamsche Waterleiding). Jan van Poelgeest. With full details and plans of the filters, together with construction costs and cost of operation, filtering 30,000 cubic metres of water per day. 4000 w. De Ingenieur—Jan. 27, 1906. No. 75152 D.

The American System of Filtration at Mansourah, Egypt. Edmund B. Weston. Illustrated description of this plant, erected by the Jewell Export Filter Co. 1500 w. Eng Rec—Feb. 10, 1906. No. 74972.

The Water Filtering and Softening Works at Columbus, Ohio. Illustrated description of a plant under construction, having features of interest which are an advance in works for inproved water supplies. 6000 w. Eng Rec—Feb. 24, 1906. No. 75259.

Water Filtration. J. M. Smail. Deals with European methods of slow filtration, and American method of rapid, or mechanical filtration. 3200 w. Aust Min Stand—Jan. 3 and 10, 1906. Serial. 2 parts. No. 74979 each B.

Water Filtration and Purification at New Orleans. John Lewis Porter. Explains the character of the water and reviews the work formerly attempted to purify it, and the results, describing the proposed plant and method of treatment. 2500 w. Munic Jour & Engr—Feb. 7, 1906. No. 75007.

Irrigation.

A Diagram to Aid the Location of Small Irrigation Canals. Paul McGeehan. Gives diagram and table that have been used for laying the grade lines on the smaller irrigating ditches of the Klamath Project of the U. S. Reclamation Service. 600 w. Eng News—Feb. 1, 1906. No. 74806.

The Belle Fourche Irrigation Works, South Dakota. Walter W. Patch. An illustrated account of this interesting work, including a concrete diverting dam, a large canal, a long, high earth dam, a main and lateral canal system covering 90,000 acres, and a new township. 2500 w. Eng News—Feb. 22, 1906. No. 75248.

New York.

Report of the New York State Water Supply Commission. Extracts from the report, especially the state water supply system recommended in the report of Myron S. Falk. 2000 w. Eng News—Feb. 8, 1906. No. 74915.

Ozone.

Isolated Plants for the Sterilization of Water by Ozone (Einzelanlagen zur Sterilisation von Trink und Industriewasser durch Ozon). Dr. G. Erlwein. Describing a convenient arrangement of the Siemens & Halske apparatus to be operated in connection with the public electric lighting circuit. Serial. Part I. 2000 w. Gesundheits-Ingenieur—Feb. 10, 1906. No. 75151 B.

Pipe Joints.

Socket Joints for Cast-Iron Pipes (Gusseiserne Muffenrohrverbindungen). Gustav Simon. An illustrated study of the proportions of the bell or socket connections used in Germany for water and gas pipe of cast-iron. 2500 w. Stahl u Eisen—Feb. 1, 1906. No. 75136 D.

Reservoirs.

Reinforced-Concrete Reservoir at Fort Meade. Illustrated description of a 500,000 gal. reservoir with a flat slab roof carried by beams and girders supported on square reinforced-concrete columns. 1800 w. Eng Rec—Feb. 10, 1906. No. 74974.

Water Works.

The New Water Works of Port Elizabeth, Cape of Good Hope. Illustrations and general information concerning important works in course of construction in South Africa. 1100 w. Eng Rec—Feb. 3, 1906. No. 74862.

Wisconsin.

The Sources of Water Supply in Wisconsin. William Gray Kirchoffer. Describes the sources of both surface and ground waters from which cities and villages are supplied. Illus. 21000 w. Bul Univ of Wis, No. 106—Jan., 1906. No. 75297 E.

WATERWAYS AND HARBORS.

Canal Haulage.

Electric Canal Haulage. Frank C. Perkins. An illustrated description of an equipment on trial in Germany, with short accounts of other systems. 1500 w. Ir Age—Feb. 15, 1906. No. 75001.

Colorado River.

The Break of the Colorado River into the Imperial Valley and Salton Sink. An account of the flood and damage caused by cutting a short emergency irrigation canal from the lower Colorado River. Map. 3500 w. Eng News—Feb. 22, 1906. No. 75249.

Danube.

Improvements in the Navigation of the Bavarian Danube (Die Verbesserung der Schiffbarkeit der Bayerischen Donau). With map and profile, showing the canalisation works now in progress on the Danube from Saal to Ulm. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 20, 1906. No. 75131 D.

Irrigation.

Winning the West. C. J. Blanchard. An illustrated account of the progress of the reclamation service in reclaiming the desert. 5700 w. Nat Geog Mag—Feb., 1906. No. 75201 C.

Locks.

Formulas for the Time Required to Fill and Empty Canal Locks (Einfache Formeln für die Zeitdauer des Füllens und Entleerens von Kammerschleusen). Dr. P. Kresnik. A discussion of methods of economizing water for canal locks by the use of storage basins, with formulas for computing the rate of filling and emptying under such conditions. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1906. No. 75128 D.

Panama.

Plain Facts about the Panama Canal. John F. Wallace. A straight talk about the real conditions of affairs on the isthmus, showing what red tape is costing, and emphasizing the great advantages of letting the work out by private contract. 5000 w. Engineering Magazine—March, 1906. No. 75161 B.

Testimony of John F. Stevens, Chief Engineer of the Isthmian Canal Commission, before the Senate Investigating Committee. Extracts containing the matter of most interest to engineers. 11000 w. Eng News—Feb. 8, 1906. No. 74913.

The Panama Canal. Hon Theodore P. Shonts. An address to the Commercial Club o^f^ Cincinnati, explaining the experiments with foreign labor, the arrangements for transportation facilities, and other questions. Ills. 5000 w. Nat Geog Mag—Feb., 1906. No. 75200 C.

The Report of the Board of Consulting Engineers for the Panama Canal. A summary of the report, with lengthy abstract of the majority report, favoring the sea-level canal, and recommendations of the Canal Commission approving the 85-ft. lock level plan. Also official reports on the plans. Ills. 16800 w. Eng News—Feb. 22, 1906. No. 75247.

River Regulation.

Regulation Works in Upper Austria (Die Gewässerregulierung in Oberösterreich). S. Stern. Illustrating the improvement works which have been conducted on the Ager and its tribuaries in the districts of St. Georgen, Berg, and Vöcklamarkl, upper Austria. 3000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 27, 1906. No. 75132 D.

Sedimentation.

Sedimentation: Its Relation to Drainage. J. W. Dappert. Abstract of a paper presented at meeting of the Illinois Soc. of Engrs. & Survs. A study of the sedimentation in drainage work, with a statement of the writer's conclusions. 3000 w. Eng News—Feb. 1, 1906. No. 74810.

MISCELLANY.

Sand Waves.

Sand Waves and Their Work. Day Allen Willey. An illustrated article describing the formations of sand dunes, and the effect of winds, and the methods that have been tried to check the movement of the sand. 1800 w. Sci Am—Feb. 24, 1906. No. 75086.

Specifications.

Decision on Appeal in the Manhattan Bridge Contract Case. Also editorial. Gives the main parts of the opinion that specifications on public contracts must accurately define the work. 5400 w. Eng News—Feb. 1, 1906. No. 74807.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

Advantageous Use of Highly Magnetic Metal in Radiation Conductors. James Foster King. Gives deductions from the effects obtained in some qualitative experiments along this line. 1400 w. Elec Wld—Feb. 10, 1906. No. 74971.

Braun's New Method of Directing Wireless Messages. A. Frederick Collins. Describes a new method for directing wireless messages, based on the theory of wave intensification and rarefaction by interference. 1200 w. Sci Am—Feb. 3, 1906. No. 74811.

The De Forrest Syntonic System of Wireless Telegraphy. A. Frederick Collins. Describes the improvements that have been introduced in this system, especially the use of Lecher's wires as a tuning and syntonizing device. Diagrams. 4200 w. Sci Am Sup—Feb. 10, 1906. No. 74955.

Transmitting Distance in Wireless Telegraphy. Capt. L. D. Wildman. Discusses the formula deduced by J. Erskine-Murray for indicating the limit of distance in transmission, and gives the writer's opinion in regard to the influence of the weather at the sending station, based on experience in Alaska. 1000 w. Elec Wld—Feb. 10, 1906. No. 74970.

Telephony.

A Review of Telephone Patents Issued in 1905. Edward E. Clement. A brief commentory on the most interesting and significant of these patents. 4000 w. Elec Rev, N Y—Feb. 3, 1906. Serial. 1st part. No. 74825.

The Post-Office Telephone System. Illustrated description of the new "City" exchange in London. 2500 w. Elec Rev, Lond—Jan. 26, 1906. Serial. 1st part. No. 74876 A.

DISTRIBUTION

Boosting.

A New Method of Automatic Boosting. Max J. E. Tilney. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Describes a system of automatic regulation on the shunt field, dealing only with the apparatus as applied to boosters and batteries. Also discussion. 5000 w. Elect'n, Lond—Jan. 26, 1906. No. 74879 A.

Cables.

The Manufacture, Application, and Distribution of Electric Cables for Collieries. George G. L. Preece. An illustrated article dealing exclusively with electric cables for colliery working. Describes various types of cable, considers the system and best form and method of erecting. 8800 w. Ir & Coal Trds Rev—Jan. 26, 1906. No. 74883 A.

Rectifier.

Mercury Arc Rectifier for Charging Storage Batteries. A Frederick Collins. Illustrated description of the General Electric Co.'s mercury arc rectifier. 1200 w. Sci Am—Feb. 17, 1906. No. 75026.

Transformers.

Large Transformer Units for Power Distribution. J. N. C. Holroyde. Explains the work for which these large transformers are employed, and illustrates and describes types in use, methods of cooling, etc. 2000 w. Elec Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74874 A.

Wales.

Electric Power Distribution in North Wales. Outlines the general features of this scheme and gives illustrated description of interesting details. The system is driven entirely by water power, and will transmit power over considerable distances at extra high pressure. 1200 w. Elect'n, Lond—Jan. 26, 1906. Serial. 1st part. No. 74877 A.

Wiring.

The Electric Wiring of Small Buildings during Course of Erection. R. Robson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Considers the means of getting a good installation at small expense, especially in small dwellings. 4000 w. Elec Engr, Lond—Feb. 9, 1906. No. 75060 A.

Wiring with Wooden Mouldings. Louis J. Auerbacher. An illustrated article giving suggestions for the selection of material and laying out of the work, and the proper methods of executing. 2000 w. Elec Wld—Feb. 3, 1906. No. 74907.

ELECTRO-CHEMISTRY.

Calculations.

Electrochemical Calculations. Joseph W. Richards. Developing formulas for the values of electrical energy in thermal and mechanical units for the expression of the effects of electrical currents. 3500 w. Serial. Part I. Jour Frank Inst—Feb., 1906. No. 75094 D.

Carborundum.

The Carborundum Furnace. F. A. J. Fitzgerald. With longitudinal and transverse sections of the electric furnace for the production of silicon carbide, and a discussion of the efficiency of its operation. 1700 w. Electrochem & Met Ind—Feb., 1906. No. 74910 C.

Current Density.

The Rôle of Current Density in Electrolytic and in Electric Furnace Processes. Discusses the rôle of current density in each case, and shows the necessity of watching it and adjusting it to the needs of the moment. 2000 w. Elec-Chem & Met Ind—Feb., 1906. No. 74908 C.

Electro-Metallurgy.

Electro-Metallurgy in 1905. A survey of the progress in the various branches of electro-metallurgy in 1905. 2000 w. Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74886 A.

Nitrates.

The Electric Production of Nitrates from the Atmosphere. Prof. Silvanus P. Thompson. A lecture at the Royal Inst. Explains and demonstrates the ingenious process for the "fixation" of nitrogen devised by Prof. Birkeland and developed with the assistance of Herr Eyde, giving figures of cost, and showing its industrial importance. 6800 w. Elect'n, Lond—Feb. 9, 1906. No. 75062 A.

The Utilization of Atmospheric Nitrogen (Utilisation de l'Azote Atmosphérique). A Boileau. A review of the various electro-chemical methods which have been proposed for the fixation of atmospheric nitrogen for the production of ammonia and nitrates. 1800 w. Génie Civil—Jan. 20, 1906. No. 75112 D.

Progress.

Electro-Chemical and Electro-Metallurgical Progress in 1905. F. S. Spiers. Reports steady and satisfactory progress in both industries, discussing the developments. 2200 w. Elec Rev, Lond—Feb. 16, 1906. Serial. 1st part. No. 75273 A.

ELECTRO-PHYSICS.

Electrons.

Mechanical Technical Discussions (Mechanisch-Technische Plaudereien). Dr. G. Holzmuller. A review of the latest electrical theories, with especial reference to the theory of electrons. Two articles. 7500 w. Zeitschr d Ver Deutschr Ing—Jan. 20, 27, 1906. No. 75101 Each D.

Gravitation.

The Problem of Gravitation. Charles Morris. A study presenting briefly some of the hypotheses which have been offered in explanation. 5500 w. Jour Fr Inst—Feb., 1906. No. 75093 D.

High Tension.

Simple Experiments with Currents of High Tension and Frequency. Thomas

R. Hopper. Describes a few examples of simple experiments which can be performed with inexpensive apparatus. 1400 w. Sci Am Sup—Feb. 17, 1906. No. 75029.

Radio Activity.

The Diminution of the Radio-Activity of Polonium with the Lapse of Time. (Sur la Diminution de la Radioactivité du Polonium avec le Temps) Mme. Curie. Deriving an exponential equation for the rate of diminution, with experimental values for the constant. 1500 w. Comptes Rendus—Jan. 29, 1905. No. 75117 D.

The Duration of the Discharge in an X Ray Tube (Sur la Durée de la Décharge dans un Tube à Rayons X). André Broca. Description of experimental demonstration that the duration of the discharge is about 0.0005 second. 1000 w. Comptes Rendus—Jan. 29, 1906. No. 75116 D.

Rectifier.

The Rectification of Alternating Currents. P. Rosling. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. and of discussion. Explains the operation of the electrolytic rectifier and the mercury arc rectifier. 3500 w. Elect'n, Lond—Feb. 9, 1906. No. 75063 A.

Transformer.

Simple Transformer for Amateur Use. Edmund S. Smith. Describes and illustrates a small transformer easily built by any one familiar with tools, at a cost of about $3.50 for materials. 1000 w. Sci Am Sup—Feb. 17, 1906. No. 75028.

GENERATING STATIONS.

Alternators.

The Design of Alternators, with Reference to Voltage Variations (Die Dimensionierung der Wechselstrommaschinen mit Rücksicht auf Spannungsänderung). W. Wittek. Deriving formulas for the dimensions of the various details of alternators for given conditions of efficiency and temperature. 2500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75144 D.

Central Stations.

A Modern Central Station Plant. Illustrated detailed description of the "No. 3" steam-operated station of the Edison Electric Company of Los Angeles, Cal. 1500 w. Power—Feb, 1906. No. 74896 C.

Combined Plants.

The Economy of Combined Railway and Lighting Plants. Read at meeting of the N. W. Elec. Assn. Ernest Gonzenbach. Considers some of the commercial and economical features in the operation of combined railway and lighting plants. 3000 w. St Ry Rev—Feb. 15, 1906. No. 75231 C.

The Economy of Combined Railway and Lighting Plants. Ernest Gonzenbach. Abstract of a paper read before the N. W. Elec. Assn., at Chicago. Discusses the saving to be effected by combining railway and lighting service. 900 w. Elec Wld—Jan. 27, 1906. No. 74792.

Developments.

Modern Electrical Developments. G. F. Metzger. Abstract of a paper before the Manchester Assn. of Engrs. Deals with electric supply as given from central stations or private plants for lighting, tramway, or motive power. 3500 w. Mech Engr—Feb. 3, 1906. No. 74986 A.

Hydro-Electric.

Hydro-Electric Plant at Montereale. Illustrates and describes a plant which utilizes the energy of the Cellina River, and is intended to transport electricity for lighting and power purposes to Venice and surrounding districts. 2000 w. Engr, Lond—Feb. 9, 1906. No. 75066 A.

The Hydro-Electric Station at Entraygues (L'Usine Hydro-Electrique d'Entraygues). P. Cafourier. Illustrated description of a station on the Argens, in the south of France, deriving about 3000 h. p. for delivery to Toulon and its environs. 3500 w. 1 plate. Génie Civil—Feb. 3, 1906. No. 75114 D.

The Kaiser Hydro-Electric Station (Die Kaiserwerke). S. Herzog. An illustrated description of the plant at Kufstein, in Tyrol, arranged to develop 3600 h. p. by tapping the Hintersteinsee. Serial. Part I. 3000 w. Elektrotech u Maschinenbau—Feb. 11, 1906. No. 75147 D.

Isolated Plants.

Isolated Plants. H. L. Woolfenden. Gives facts concerning a typical office-building plant, and its features of interest. 2300 w. Elec Rev, N Y—Feb. 17, 1906. No. 75033.

Mechanical Plant of the New Wanamaker Store in New York. Illustrated detailed description of a plant to provide for the generation of electricity for lighting and power purposes, and also the heating, ventilating and general mechanical service of one of the largest department stores in the world. 4500 w. Eng Rec—Feb. 24, 1906. Serial. 1st part. No. 75261.

The Heating and Lighting Plant at Bryn Mawr College. George C. G. Gray. Illustrated detailed description of a central plant to serve a group of buildings. 3800 w. Eng Rec—Feb. 17, 1906. No. 75054.

The Mechanical Plant in the Tietz Store in Munich. Notes and illustrations from an article by Julius Weil, in the *Zeit-*

schrift of the Soc. of German Engrs. Diesel engines are used. 1800 w. Eng Rec —Feb. 10, 1906. No. 74977.

Springfield, Ill.

The Springfield, Ill., Light, Heat and Power Co.'s Station and System. Illustrated detailed description. 3800 w. Elec Wld—Feb. 3, 1906. No. 74906.

Supervision.

The Proposed Official Supervision of Electric Plants (Die Beabsichtige Staatliche Ueberwachung Elektrischer Anlagen). H. Passavant. A discussion of the proposition to subject electrical installations in Germany to official regulations and supervision. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75103 D.

Supply.

Central Stations versus Isolated Plant. Albert Yost. Discusses the economy of the service, and the conditions under which a private plant will pay. 2000 w. Power. Feb., 1906. No. 74902 C.

Switzerland.

The Installations of the Vaudoise Motor Power Company at the Lakes of Joux and Orbe, Switzerland. Franz Koester. Illustrates and describes interesting details of the installation. 3000 w. Elec Rev, N Y—Feb. 10, 1906. No. 74962.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. Leonard J. Pumphrey. An illustrated article presenting the advantages of these lamps, claiming great efficiency, and describing their construction. 2800 w. Elec Engr, Lond—Feb. 2, 1906. No. 74990 A.

Incandescent.

The New Metallic Filament Lamp of Dr. Hans Kuzel (Einiges über die Neuen Metallfaden Lampen nach Verfahren Dr. Hans Kuzel). John. Kremenezky. Data and results of tests upon a new filament of which the composition is not given. The current consumption is about 1 watt per Hefner candle, with a life of 1,500 hours. 1500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75146 D.

Interiors.

The Lighting of Dining and Bed Rooms. J. R. Cravath and V. R. Lansingh. Discusses good and bad arrangements for the lighting of these rooms by electricity. Ills. 3800 w. Elec Wld—Feb. 3, 1906. No. 74905.

Progress.

The Progress in Electric Lighting. Leon Gaster. Describes the present manufacture of carbon filament lamps, discussing the quality, candle power, etc., the proper selection of lamps, shades, improved filaments and other marks of progress. Discussion. 11800 w. Jour Soc of Arts—Feb. 9, 1906. No. 75064 A.

Shops.

Store Lighting. E. Leavenworth Elliott. Points in showing different wares to advantage, and the means of securing efficiency in store lighting and the lighting of show windows. 1500 w. Cent Sta—Feb, 1906. No. 74957.

Waste.

Waste in Incandescent Electric Lighting and Some Suggested Remedies. George Wilkinson. Abstract of a paper before the Leeds Loc. Soc. of the Inst. of Elec. Engrs. Notes instances of waste that have come under the writer's notice, suggesting remedies. 4500 w. Elect'n, Lond—Feb. 16, 1906. No. 75278 A.

MEASUREMENT.

Instruments.

Iron-Cored Alternate-Current Instruments. W. E. Sumpner. Abstract of a paper in the *Journal* of the Inst. of Elec. Engrs. (England). Discusses the difficulties in regard to the accurate working of such instruments, the errors due to incorrect phase relations, etc. 3300 w. Elect'n, Lond—Feb. 2, 1906. No. 74989 A.

Some Recent Electrical Measuring Instruments. Kenelm Edgcumbe. A review of recent progress in ampere gauges, wattmeters, photometers, etc. Ills. 3500 w. Elec Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75059 A.

Meters.

The Proper Handling of Consumers' Meters. George H. Barrett. Abstract of a paper read before the N. W. Elec. Assn., at Chicago, and of the discussion. Gives suggestions for the care and testing of meters, and ways of satisfying customers as to their accuracy. 2000 w. Elec Wld—Jan. 27, 1906. No. 74791.

Wattmeters.

Series Transformers for Wattmeters. Lancelot W. Wild. Explains the object of this arrangement, and discusses the need of careful designing, describing a design for the Westminister Electrical Testing Laboratory. 1800 w. Elect'n, Lond—Feb. 16, 1906. No. 75275 A.

TRANSMISSION.

Transmission Circuits.

Induction in Transmission Circuits. Charles F. Scott. An elementary consideration of the physical basis underlying self induction and mutual induction. 3000 w. Elec Jour—Feb. 1906. No. 75269.

MOTORS.

Cranes.

Crane Motors and Controllers. Claude W. Hill. Gives some of the more common methods of specifying, and the method of calculation to ascertain the load and time which shall produce a rise in temperature equal to that produced in the usual way of working, discussing the requirements of controllers. Tables and diagrams. 4000 w. Inst of Elec Engrs—Feb. 8, 1906. No. 75061 D.

Induction Motors.

A Contribution to the Theory of the Single-Phase Induction Motor. Val A. Fynn. A study of the theory of the asynchronous single-phase induction motor, showing the reasons for its operation and its relation to the continuous-current motor. 2300 w. Elec Rev, Lond—Feb. 9, 1906. Serial. Part I. No. 75081 A.

Armature Reaction in Polyphase Motors (Ankerrückwirkung in Drehstromgeneratoren). J. K. Sumec. Deriving formulas for computing the excitation, with practical applications to the design of motors. Two articles. 6000 w. Elektrotech u Maschinenbau—Jan. 21, 1906. No. 75143 Each D.

Magnetic Field in the Induction Motor. A. S. M'Allister. Quotes statements made in an article published in this *Journal* in Nov., 1904, and discusses the facts upon which the statements are based, to show that the space distribution of the revolving magnetic flux follows a line law, and to outline a method by which the implied considerations can be utilized in the treatment of induction motor phenomena. 3500 w. Sib Jour of Engng—Feb., 1906. No. 75270 C.

The Magnetism in Induction Motors. H. F. and H. W. Connell. Gives an outline of an investigation undertaken to determine how nearly the present commercial induction motor follows the theoretical laws regarding the impressed e. m. f. wave form and its relation to the resultant wave form of the flux; also editorial. 1800 w. Elec Wld—Feb. 24, 1906. No. 75266.

Winding Faults in Induction Motors. E. B. Raymond. Shows how by taking simple readings the winding condition can be determined and a correction applied. 1700 w. Engr, U S A—Feb. 15, 1906. No. 75058 C.

Inter-Pole Motor.

The Reincarnation of an Electrical Idea. Frank J. Sprague. An explanation of the value of the inter-pole motor in connection with direct-current operation. 2000 w. Elec Wld—Feb. 24, 1906. No. 75265.

MISCELLANY.

Lectures.

Elementary Lectures on Electrical Engineering. This first of a series of articles explains some of the fundamental principles. Ills. 1200 w. Power—Feb., 1906. Serial. 1st part. No. 74899 C.

Review.

The Electrotechnical Industries in the Year 1905 (Die Elektrotechnische Industrie im Jahre, 1905). Emil Honigmann. A general review of the progress of the electrical industry in Europe, with special reference to developments in Austria-Hungary. Tabulated comparisons for 1904 and 1905 are given. Serial. Part I. 4000 w. Elektrotech u Maschinenbau—Jan. 14, 1906. No. 75141 D.

Statistics.

The Electric Power Companies. The annual sheet of statistics of the electric power companies of the United Kingdom, with editorial. 3000 w. Elect'n, Lond—Jan. 26, 1906. No. 74878 A.

INDUSTRIAL ECONOMY

Agriculture.

Agricultural Machinery in the Beginning of the Twentieth Century (Le Materiel Agricole au Debut du XX Siecle). Max Ringelmann. An exhaustive review of the application of engineering to the development of agriculture, including the development of agricultural machinery and appliances during the nineteenth century, and their influence upon the status of agricultural labor, and national economy. 15,000 w. Bull Soc d'Encour—Oct., Nov., 1905. No. 75180 each G.

Apprentices.

Technical Training and the Apprenticeship Question. (L'Enseignement Professionnel et la Question de l'Apprentissage). M. Alfassa. A study of apprenticeship in France, in connection with technical instruction, giving a summary of the plan for the education of apprentices adopted in France by the Conseil Superieur du Travail. 8000 w. Bull Soc d'Encour—Nov., 1905. No. 75181 G.

Contracts.

The "Indiana" Claim in the Court of Claims. George A. King and William B. King. A review of this suit which is of importance to contractors with the U. S. Government. 2400 w. Eng Rec—Feb. 17, 1906. No. 75056.

Copper Trade.

The World's Copper Trade in 1905. Horace J. Stevens. A review of the year showing much the largest production of copper ever known. 4500 w. Min Wld—Jan. 27. 1906. No. 74777.

Costs.

The Estimation of Costs. Abstract of a paper by A. W. Farnsworth, read before the Coventry Engng. Soc. Interesting suggestions concerning the employment of better men for cost-keeping. 2500 w. Eng Rec—Feb. 3, 1906. No. 74864.

Education.

A Municipal School of Marine Engineering. Editorial on the Poplar School, recently opened in London. 2800 w. Engng—Jan. 26, 1906. No. 74895 A.

Investigations and Commercial Tests in Connection with the Work of an Engineering College. Prof. D. S. Jacobus. Address before the Am. Assn. for the Adv. of Science. Presents the advantages and disadvantages of research work and outside work. 3200 w. Am Mach—Vol. 29. No. 6. No. 74937.

Laboratory Training. C. H. Benjamin. An illustrated article discussing the aim of laboratory work and how best to make the work of benefit. Describes briefly the power laboratory of the Case School, indicating how it is being used. 2000 w. Mach, N Y—Feb, 1906. No. 74800 C.

The Application of Science to Industry. Editorial review of the Final Report of the Departmental Committee on the Royal College of Science, etc. 4000 w. Engng—Feb. 9, 1906. No. 75076 A.

The Dresden Technical High School. Begins an illustrated detailed description of the new mechanical department and its equipment. 1800 w. Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74890 A.

The Technical Training of Apprentices. Prof. Sir W. Ripper. Discusses the standing of technical education in England, and the attitude of employers. 2200 w. Engr, Lond—Feb. 9, 1906. No. 75070 A.

Germany.

The American and the German Peril. Louis J. Magee. The third and concluding article treats of American trade methods as tested by German experience. 2500 w. Engineering Magazine—March. 1906. No. 75162 B.

Industry.

The Importance of Industrial Studies for the Work of the Engineer (Die Bedeutung Wirtschaflicher Studien für den Stand der Ingenieure). H. Kollman. A review of the relation of engineering work to the economic and industrial development of a nation. 4000 w. Zeilschr d Ver Deutscher Ingenieure—Jan. 20, 1906. No. 75104 D.

Labor.

Method of Exporting Chinese Coolies to the Transvaal. An explanation of the system established by the Chinese Government, for the enlistment of coolies for work in the mines of the Transvaal. 2200 w. Min & Sci Pr—Jan. 27, 1906. No. 74846.

Laboratory Appliances.

Labor-Saving Appliances in the Laboratory. Edward Keller. Describes and illustrates a number of improved methods and apparatus introduced in the newly equipped assay laboratory of the Anaconda Copper Mining Co. in Baltimore. 2800 w. Jour Fr Inst—Feb, 1906. No. 75092 D.

Metric System.

The Metric System Fallacy. W. M. McFarland. Abstract of testimony on this subject, given before the American Congressional Committee on Coinage, Weights and Measures. 3500 w. Cassier's Mag—Feb, 1906. No. 74919 B.

Production.

Concentration in Manufactures. Editorial discussion of the effect of such systems upon economy of production. 2000 w. Engng—Feb. 16, 1906. No. 75288 A.

Profit-Sharing.

Shop Betterment and the Individual Effort Method of Profit-Sharing. Harrington Emerson. Discusses the shop problem of the present, and explains a system of profit-sharing believed to include all that is best in other methods, and to exclude much that is objectionable. 4000 w. Am Engr & R R Jour—Feb. 1906. No. 74853 C.

Valuation.

The Valuation of Machinery for Rating Purposes. Frederick Marshall. Abstract of a paper read before the Surveyor's Inst. Discusses British law on the rating of machinery, citing several cases. 3000 w. Ir & Coal Trds Rev—Feb. 16. 1906. No. 75293 A.

Works Management.

The Square Deal in Works Management. O. M. Becker. The third article discusses the attempts which have been made to better the physical condition of workers, by providing lunch rooms, seats, proper sanitary conveniences, etc., in many large establishments. 6000 w. Engineering Magazine—March, 1906. No. 75163 B.

MARINE AND NAVAL ENGINEERING

Collier.

A 12,000 Ton Floating Collier (Schwimmender Kohlenspeicher für 12,000 t.). W. Kaemmerer. An illustrated description of coaling apparatus built by the Temperly Transporter Co., for the harbor of Portsmouth. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1906. No. 75106 D.

Docks.

Docks for Torpedo Boats at the Imperial Yards at Kiel (Dockanlage für Torpedoboote auf der Kaiserlichen Werft Kiel). Ph. von Klizing. An illustrated description of the new floating docks built by the Howaldtswerk for the special purpose of overhauling torpedo boats. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75102 D.

Education.

See Industrial Economy.

Engines.

See Mechanical Engineering, Steam Engineering.

Ferry-Boat.

Petrol Motor-Driven Ferry Boat "Swallow." Detail drawings with description. 900 w. Engng—Feb. 9, 1906. No. 75074 A.

Liner.

The New P. & O. Liner Dongola. Benjamin Taylor. Illustrates and describes the latest vessel designed for the Eastern mail service, combining speed and spacious passenger accommodations. 1700 w. Marine Engng—Feb, 1906. No. 74831 C.

Liquid Fuel.

Liquid Fuel for Naval and Marine Uses. George Melville. Gives a résumé of some of the important points covered by the report of the Board appointed to investigate the liquid fuel problem in its application to marine uses. 3000 w. Sci Am Sup—Feb. 3, 1906. Serial. 1st part. No. 74813.

Paddle Steamships.

Early American Paddle Steamships. Gives a list of the principal paddle steamships built in the United States, with information concerning them. 1000 w. Naut Gaz—Feb. 1, 1906. No. 74830.

The American Paddle Steamship Golden Age. Illustrated description of a vessel built in New York in 1853, which made at that time record-breaking trips out to Australia and return across the Pacific. 2200 w. Naut Gaz—Feb. 1, 1906. No. 74829.

Screw Propellers.

The Screw Propeller Controversy. James Howden. Explains why the subject is brought up and reviews the writer's previous papers and the discussions that followed their presentation, defending the writer's views. 16600 w. Trans Inst of Engrs & Shipbuilders in Scotland—Jan. 23, 1906. No. 75296 D.

Shaft Torsion.

Torsion Indicator Diagrams of Marine Engines. A study of the investigations recently made in Germany upon the torsion of screw propeller shafts, with diagrams, showing the nature of the stresses. 3000 w. Engng—Jan. 26, 1906. No. 74892 A..

Shipping.

Shipping on the Great Lakes. W. I. Babcock. Lecture at the Inst. of Technology, Boston. Describes the physical characteristics of the lakes and connecting waters, and the classes of boats the service requires, the immense amount of business, the methods of loading and unloading, etc. 6000 w. Marine Rev—Feb. 22, 1906. No. 75244.

Shipping Bill.

Text of Shipping Bill. Gives the full text of the new ship subsidy bill which passed the Senate of the United States on Feb. 14. 3500 w. Naut Gaz—Feb. 22, 1906. No. 75243.

Shipyards.

London Works, Renfrew. An illustrated description of works for building dredgers, barges, and dredger plants generally, with illustrated types produced. The works have recently been extended and rearranged. 2700 w. Engr, Lond—Feb. 16, 1906. No. 75280 A.

Scott's Shipbuilding and Engineering Works at Greenock. An illustrated article giving the history and description of an industry maintained for 200 years by one family, and in one locality. 6000 w. Engng—Feb. 9, 1906. No. 75071 A.

Steamers.

A Wooden Passenger Steamer for Onedia Lake. Illustrates and describes a new passenger steamer, and its power equipment. 1600 w. Marine Engng—Feb, 1906. No. 74832 C.

Steam Trawler.

The New Steam Trawler Spray. Illustrated description of a typical North Sea steam trawler introduced among the fleets of Boston and Gloucester deep-sea fisher-men, with an account of the method of catching the fish. 2000 w. Naut Gaz—Feb. 1, 1906. No. 74828.

Submarines.

Submarine Navigation. Sir William H. White. An address before the Roy. Inst. of Gt. Britain. Refers to efforts made as early as 1860, and reviews the progress and development, especially the modern types. The conditions to be met are described, and the equipment of such vessels. 5000 w. Pop Sci M—March, 1906. No. 75232 C.

Torpedo Boats.

The Future of Torpedo Craft. Archibald S. Hurd. Reviews the development of torpedo boat destroyers, illustrating types built, and discussing their value in warfare, and indicates some changes in construction of torpedo craft due to observations made during the Russian-Japanese war. 4000 w. Cassier's Mag—Feb, 1906. No. 74920 B.

The Yarrow-Napier Torpedo Boat. Illustrations, with description of a second-class motor torpedo boat recently launched 1100 w. Auto Jour—Jan. 27, 1906. No. 74869 A.

Turbines.

The History of the Marine Turbine. Reviews the history from the Turbinia of 1894 to the Carmania of 1905. Ills. 2800 w. Mach, N Y—Feb, 1906. No. 74801 C.

Warships.

The "Dreadnought." Editorial review of this recently launched vessel, said to be the most powerfully armed, the best protected, and the fastest battleship ever laid down. 4000 w. Engng—Feb. 9, 1906, No. 75075 A.

MECHANICAL ENGINEERING

AUTOMOBILES

Chassis.

A Discussion of the 1906 Chassis. Forrest R. Jones. Discusses in detail the present automobile practice, especially in pleasure cars of the larger size. 3500 w. Automobile—Feb. 8, 1906. Serial. 1st part. No. 74928.

The 40 h. p. Crossley-Critchley Car. Illustrates and describes a fine example of English automobile engineering, shown at the Edinburgh Exhibition. 1400 w. Autocar—Feb. 3, 1906. No. 74982 A.

Exhibition.

New Exhibits in Cars at Chicago. Illustrated detailed description of cars displayed which were not shown at New York. 6000 w. Automobile—Feb. 15, 1906. No. 75008.

The Progress of Automobilism in 1905 (Les Progrès de l'Automobilisme en 1905). F. Drouin. A fully illustrated description of the Salon exhibition of the Automobile Club of France, with details of novelties in construction. Three articles. 6000 w. Génie Civil—Jan. 20, 27, Feb 3, 1906. No. 75111 each D.

Ignition.

The Lacoste Magneto. Explains the construction and operation of this high-tension, self-contained magnet. Ills. 1600 w. Autocar—Jan. 27, 1906. No. 74871 A.

Lubrication

Lubrication and Its 1906 Forms. An illustrated article describing the oilers and present practice for lubricating automobiles, as shown at the recent New York exhibitions. 3300 w. Automobile—Feb. 1, 1906. No. 74842.

Motor Cars.

The Horseless Carriage — 1885-1905. Claude Johnson. A review of the first twenty years of the "petrol" movement, or of mechanical road locomotion. Discusses principally automobilism in the United Kingdom. General discussion. 21-000 w. Jour Soc of Arts—Feb. 16, 1906. No. 75268 A.

Motor Skate.

The Motor Skate.—A New Thousand League Boot. Illustrates and describes the invention of M. Constantini, of an automobile skate driven by a small gasoline motor. 700 w. Sci Am—Feb. 10, 1906. No. 74950.

National.

National 6- and 4-Cylinder 1906 Models. Illustrated descriptions of two new touring cars. 2000 w. Automobile—Feb. 1, 1906. No. 74843.

The 3-Cylinder "National" Car. Illustrated description of important improvements made in this British car. 1200 w. Auto Jour—Feb. 10, 1906. No. 75080 A.

Racers.

Final Races at the Ormond Automobile Meet. Illustrations of some of the record-holding racers, with report of their performance. 1700 w. Sci Am—Feb. 10, 1906. No. 74953.

Shocks.

Types of American Shock Absorbers. Illustrates and describes devices for deducing the effect of shocks to the springs and body of a car when traveling rough roads. 3000 w. Automobile—Feb. 8, 1906. No. 74929.

Six-Cylinder.

Six-Cylinder Cars at the Shows. Illustrates and describes the six-cylinder cars shown at the recent exhibitions in New York. 3500 w. Automobile—Feb. 1, 1906. No. 74841.

Spyker.

The 1906 Spyker Cars. An illustrated article describing the alterations introduced in the latest cars. 1800 w. Auto Jour—Feb. 3, 1906. No. 74981 A.

Tractors.

Petrol-Motor Tractors for Military Use. Illustrates and describes two lately constructed motor tractors, one of 40-brake-h. p. and the other of 25-brake-h. p. 700 w. Engng—Feb. 2, 1906. No. 74995 A.

Truck.

The Four Wheel Drive Truck. Illustrated description of a new model, bevel gear-driven to both front and rear axles. there being no chains employed. 1000 w. Ir Age—Feb. 15, 1906. No. 75002.

COMBUSTION MOTORS.

Balancing.

Balancing of Petrol Engines. Archibald Sharp. Explains the principal phenomena involved in the "balancing" of the engine, in a manner intelligible to the non-technical reader. 1800 w. Autocar—Jan. 27, 1906. Serial. 1st part. No. 74870 A.

Gas Analysis.

Improved Orsat Apparatus for Gas Analysis (Neue Orsat-Apparate für die Technische Gasanalyse). Dr. C. Hahn. The improved absorption apparatus enables the hydrogen, methane, carbon monoxide and dioxide, and heavy hydrocarbons in fuel illuminating, or waste gases, to be quantitatively determined. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75118 D.

Gas Engines.

Formulas and Constants for Gas Engine Design. Sanford A. Moss. Rules are given for the size of all the more important parts; the formulas are rational whenever possible, and an effort has been made to arrange everything in the most convenient form for a designer's use. 2000 w. Mach, N. Y—Feb., 1906. No. 74 798 C.

Gas Engine Construction and Economy. Helon B. Macfarland. Gives tables showing the efficiency and the relation between thermal efficiency of the engine, the heating value of the gas, and the cubic feet of gas used by an engine. 1800 w. Engr, U S A—Feb. 1, 1906. No. 74861 C.

Gas Engines as Applied to Electric Driving. James Atkinson. Abstract of a paper before the Manchester Soc. of the Inst. of Elec. Engrs. Gives particulars of three sets of engines with suction-gas plants, with information concerning methods of governing, and the driving of alternating-current dynamos, etc. Ills. 4000 w. Mech Engr—Feb. 3, 1906. No. 74985 A.

Gas Power.

Gas Engines and Gas Producers (Gasmaschinen und Kraftgaserzenger). Otto Hoffmann. With illustrations of pressure and suction gas plants; also several types of two and four cycle gas engines, giving data of operative costs. 3500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75145 D.

Gas Engines as Applied to Electric Driving. James Atkinson. Abstract of a paper before the Manchester Soc. of the Inst. of Elec. Engrs. Gives particulars of three sets of engines with suction gas plants showing how economically electric current can be generated when producer gas is used. And gives views of the relative merits and demerits of the various methods of regulating. 3000 w. Elect'n, Lond—Feb. 16, 1906. No. 75277 A.

Gas Producers

Producer Gas and Gas Producers. Charles H. Day. Discusses the methods employed to produce a suitable and sufficiently cheap gas for power purposes. 2500 w. Power—Feb, 1906. No. 74901 C.

Ignition.

The Rankin Kennedy System of Magneto Ignition. Illustrated description of a magneto ignition system for internal combustion engines in which the spark is obtained in the cylinder by means of a high-speed magneto machine working in conjunction with a trembler coil. 700 w. Engng—Feb. 16, 1906. No. 75285 A.

HEATING AND COOLING.

Heat Losses.

Calorimetric Methods of Determining the Loss of Heat from Buildings and Radiators. A. H. Barker. Read before the Inst. of Heat and Vent. Engrs (England). Suggests methods which the writer considers more reliable than most methods in use. 4500 w. Plumb & Dec—Feb. 1, 1906. No. 74980 A.

Refrigeration.

Department Store Refrigeration. Illustrates and describes refrigerating plants in Chicago department stores. 1500 w. Ice & Refrig—Feb., 1906. No. 74848 C.

Refrigeration with Electric Motive Power. Dr. Alfred Gradenwitz. Illustrated, with description of the arrangement and operation of the apparatus, showing that refrigeration is available wherever electric current can be obtained. 1100 w. Sci Am—Feb. 3, 1906. No. 74812.

The Electrical Driving of Cold Storage and Ice-Making Plants. Sydney F. Walker. Considers the application of electricity to this work, the properties of different refrigerating agents, etc. 5400 w. Elec Rev, N Y—Feb. 17, 1906. No. 75034.

Ventilation.

Centrifugal Ventilating Machines. F. Ernest Brackett. Discusses the method used by some engineers of correlating the size of the fan to the volume of the air, and the scientific basis upon which it rests. 2500 w. Eng. & Min Jour—Feb. 3, 1906. No. 74839.

Plenum Ventilation Systems for School Houses (Ueberdruck-lüftung mit Ventilatoren betrieb in Schulen). Richard Hoffmann. Discussing both warming and ventilating problems, with diagram for computing the loss of heat through windows. 5000 w. 1 plate. Gesundheits-Ingenieur—Jan. 27, 1906. No. 75149 B.

The Ventilation of Theaters (Die Lüftung der Theater). H. Pfützner. A general review of methods of theater ventilation, taking into account the relations of the stage and the auditorium, and the questions of the relative temperatures and heights of the air columns. 8000 w. Gesundheits-Ingenieur—Jan. 20, 1906. No. 75148 B.

Water Heating.

Improved Devices for Heating Water by Steam (Neuere Apparate zur Dampfwarmwasserbereitung). Paul Hoffmann. Illustrating and describing heaters of the counter-current type in which the steam and the water flow in opposite directions. 1800 w. Gesundheits Ingenieure—Feb. 3, 1906. No. 75150 B.

HYDRAULICS.

Centrifugal Pumps.

The Sulzer High Pressure Centrifugal Pumps (Sulzer-Hochdruck-Zentrifugalpumpen). S. Herzog. A general description of the multiple centrifugal pump with guide vanes, as made bv Sulzer Brothers, of Winterthur, Switzerland, with curves showing performances and efficiencies at different speeds. Three articles. 7000 w. Elektrotech u Maschinenbau—Jan. 14, 21, 28, 1906. No. 75142 each D.

Niagara.

Niagara Power Schemes. Review of a lecture by Prof. Unwin before the students of the Institution of Mechanical Engineers. An account of the stations already established, and problems which had to be considered, with brief reference to the effect on the Falls. 3700 w. Engng Feb. 16, 1906. No. 75289 A.

Pump Plant.

A Large Rotary Pump Plant. Brief illustrated description of the Pine Island plant for irrigating a Southern rice field; two pumping plants were installed in order to divide the lift. 900 w. Am Mach —Vol 29. No. 4. No. 74823.

Turbine Pump.

Large Turbine Pump for the Montreal Water and Power Company. Illustrated description of a pump designed to deliver 6½ million imperial gallons per twenty-four hours against a head of 30 ft. 1000 w. Engng—Feb. 2, 1906. No. 74996 A.

Water Power.

Adirondack Power. Alton D. Adams. On the immense undeveloped water power available from the Adirondack Mts. 1000 w. Elec Rev, N Y—Feb. 24, 1906. No. 75255.

The Water Power Development of the Chicago Drainage Canal. Illustrated detailed description of works required to develop this power. 5800 w. Eng Rec—Feb. 17, 1906. No. 75055.

MACHINE WORKS AND FOUNDRIES.

Apprentices.

See Industrial Economy.

Balancing.

Balancing at High Speeds. E. R. Douglas. Discusses the importance of accurate balancing in turbine work, and the methods and problems. 2800 w. Am Mach—Vol. 29. No. 8. No. 75234.

Castings.

Handling and Machining Large Engine Frames. B. B. Gaffer. Illustrated description of the various operations from pouring the molds to loading for shipment. 1500 w. Am Mach—Vol. 29. No. 5. No. 74815.

Open-Hearth Steel Castings. W. M. Carr. Illustrates and describes a modern stationary furnace of 20 tons' capacity. and gives some arguments in favor of movable types; also some general rules as to points of construction and volumes. 3000 w. Foundry—Feb, 1906. No. 75204.

Statuary Casting Department of the Gorham Mfg. Co., Providence, R. I. Illustrated description of the work of molding and casting statues. 1500 w. Foundry—Feb. 1906. No. 75205.

Cast Iron.

Heat Treatment of Cast Iron. P. Munnock. Gives diagrams, showing the utility of a diagram from a transverse testing machine. explaining the method of taking the diagrams. 1000 w. Ir & Coal Trds Rev—Feb. 9, 1906. No. 75222 A.

Core-Boxes.

Multiple Core-Boxes. H. W. Tuttle. Describes the making of these boxes. Ills. 1000 w. Foundry—Feb, 1906. No. 75203.

Cost-Estimates.

The Insulating Cost in the Manufacture of Dynamo-Electric Machinery. H. M. Hobart. An investigation of the cost of the labor and material entering into the insulating of dynamo-electric machinery. 2200 w. Elec Engr, Lond—Feb. 16, 1906. No. 75272 A.

Crossheads.

Making Interchangeable Crossheads, Bodies and Slippers. J. C. Dufresne. Illustrated description. 900 w. Am Mach—Vol. 29. No. 7. No. 75014.

Drills.

Design for Sliding Head for Upright Drill. H. F. Noyes. Illustrates and describes this device and its construction; the novel features are in the power feed and the automatic stop. 800 w. Am Mach—Vol. 29. No. 7. No. 75011.

Drums.

Making Countershaft Drums at the Works of the Landis Tool Company. H. F. Noyes. Illustrated detailed description. 800 w. Am Mach—Vol. 29. No. 8. No. 75235.

Electric Driving.

Motor-Drive and Machine Shop Economy. E. R. Douglas. Reviews the development of motor-driving in machine shops, stating the advantages, and the systems of speed control that have been commercially successful. 4000 w. Elec Rev, N Y—Feb. 10, 1906. No. 74963.

Power Required by Machine Tools, with Special Reference to Individual Motor Drive. G. M. Campbell. Presents deductions from the various motor equipments in a modern shop, giving curves of power and examples of every day practice; also discussion. 5800 w. Pro Engrs' Soc of W Penn—Feb, 1906. No. 75090 D.

Files.

Files and File Testing. Edward G. Herbert. An investigation of files and factors governing their efficiency. 4000 w. Am Mach—Vol. 29. No. 7. No. 75010.

Foundries.

Foundry Blackings and Partings. E. L. Rhead. Discusses in detail the various substances used for blacking the surface of molds. 3500 w. Mech Engr—Jan. 20, 1906. No. 75015 A.

Foundry Practice. William A. Bole. Read before the Pittsburg Found. Assn. Discusses the qualities of pig iron, molten irons, charcoal irons, scrap, etc., the requirements of castings, their composition and related subjects of interest. 5000 w. Ir Age—Feb. 15, 1906. No. 75004.

Foundry Problems. Dr. Richard Moldenke. Address to the Pittsburg Found. Assn. Discusses problems for improving the quality of the castings. 2000 w. Ir Trd Rev—Feb. 15, 1906. No. 75009.

Notes on American Foundry Operation (Betrachtungen über den Amerikanischen Giessereibetrieb). B. Osann. A review of a visit to the United States with especial reference to the operation of the iron and steel foundries of the larger American shops. Two articles. 4000 w. Stahl u Eisen—Jan. 15, Feb. 1, 1906. No. 75137 each D.

Gate Valves.

Some Large Gate Valves. Illustrates and describes the construction of some gate valves of 9 ft. water-way, for the Niagara Power Co. 1200 w. Am Mach—Vol. 29, No. 5. No. 74817.

Lathe.

68-In. Lathe for Turning Crank-Shafts. Illustrated description of a lathe built in Russia, for turning heavy marine-engine crank-shafts for the Newsky Shipbuilding Yard, St. Petersburg. 1000 w. Engng —Feb. 16, 1906. No. 75286 A.

Light Machinery.

Cold Drawn and Rolled Steel in the Manufacture of Light Machinery. Fred W. McArdle. Describes the work of building adding machines, the materials used, etc. Ills. 1400 w. Am Mach—Vol. 29, No. 6. No. 74939.

Melting.

Melting Ratio. John Doyle. Discusses satisfactory melting, not favoring the high melting ratio. 1000 w. Foundry—Feb., 1906. No. 75202.

Milling.

Worm Milling. John Edgar. On methods of milling worms, the shape of cutters, etc. Ills. 1500 w. Am Mach—Vol. 29, No. 6. No. 74938.

Molding.

Molding Tools and Appliances. E. L. Rhead. An illustrated article considering the tools generally used and which are necessary for even simple operations. 2800 w. Mech Engr—Feb. 3, 1906. No. 74983 A.

Organization.

The Organization of an Engineering Works. W. O. Horsnaill. Describes the shop organization, in connection with a previously described organization of the drawing-office, which will conduce to the turning out of work in the cheapest and most efficient manner. 1700 w. Engr, Lond—Jan. 26, 1906. No. 74887 A.

Pickling.

Acid Dips and Pickles for Brass Castings. H. J. Hawkins. Explains the uses of several acids in the manufacture of cast brass. 1200 w. Foundry—Feb, 1906. No. 75206.

Pistons.

Manufacturing Steam Pistons. J. M. Menegus. Illustrates and describes tools and fixtures used in making pistons. 1000 w. Am Mach—Vol. 29, No. 7. No. 75012.

Protective Devices.

Improved Protections for Grinding Wheels (Nouveaux Protecteurs pour Meules Artificielles). Henri Mamy. Discussing especially methods for the removal of dust from grinding wheels by the use of exhaust fans and flues. 1000 w. Génie Civil—Feb. 10, 1906. No. 75130 D.

Shears.

A German Electric Bloom Shear. Abstract of an article by A. Schwarze, in *Stahl und Eisen.* Illustrated detailed description of several arrangements. 1500 w. Ir Age—Feb. 15, 1906. No. 75003.

Shops.

The Colburn Machine Tool Company's Shop. Illustrated description of details and partial specifications. 4800 w. Mach, N Y— Feb, 1906. No. 74797 C.

Time Keeping.

Estimating Time on Machine Work. J. H. Van Yorx, Jr. Considers some points that may aid in estimating, suggesting methods applicable to various classes of work. 2500 w. Mach, N Y—Feb., 1906. No. 74799 C.

Valves.

The Dyblie Reversing Valve. Illustrates and describes a reversing valve adapted to open hearth, soaking pit and similar furnace installations. 800 w. Ir Age—Feb. 22, 1906. No. 75228.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys. Prof. A. Humboldt Sexton. The first of a series of articles aiming to give an account of the investigations that have been made and the facts discovered during the last few years, in so far as they are of importance to the maker and user of alloys. 2000 w. Mech Engr—Jan. 27, 1906. Serial. 1st part. No. 74872 A.

Alloy Steels.

Notes on Metals and Their Ferro-Alloys Used in the Manufacture of Alloy Steels. O. J. Steinhart. Abstract of a paper read before the Inst. of Min. & Met. Nickel, chrome, molybdenum, vanadium, tungsten, and titanium, cobalt, uranium, and tantalum are briefly considered. 2800 w. Ir & Coal Trds Rev—Jan. 26, 1906. No. 74882 A.

The Industrial Future of Special Steels. Léon Guillet. A brief review of these steels and their properties. 2400 w. Ir & St Mag—Feb., 1906. No. 75095 D.

The Manipulation of High-Speed Steels. W. J. Todd. Hints for the working of these steels. 1500 w. Mach, N. Y.—Feb., 1906. No. 74802 C.

Bauxite.

Refractory Uses of Bauxite. A. J. Aubrey. Reports some tests made with bauxite bricks and mentions their uses for open-hearth furnaces, the lining of kilns, and lead-refining furnaces. 2200 w. Ir Trd Rev—Feb. 1, 1906. No. 74814.

Brittleness.

The Effect of Nitrogen on Iron and Steel. Abstract of a monograph by Dr. Hjalmar Braune, discussing the effect of minute quantities of nitrogen in producing brittleness in iron and steel. 800 w. R R Gaz—Vol. XL. No. 6. No. 74949.

Bronze.

Manganese-Bronze and Its Manufacture. Edwin S. Sperry. Abstract from an article in the *Brass World.* Gives the history of this alloy, explaining the theory and describing the manufacture. 3000 w. Am Mach—Vol. 29. No. 5. No. 74816.

Nickel Steel.

Nickel Steel and Its Application to Boiler Construction. G. B. Waterhouse. A brief survey of the properties of nickel steel that make them especially adapted for this use. 2000 w. Ir Age—Feb. 8, 1906. No. 74903.

Testing.

Impact Testing. Capt. Riall Sankey. Remarks concerning the various shock or impact tests at present in use, describing more particularly the one-blow method. 4800 w. Engr, Lond—Jan. 26, 1906. No. 74889 A.

Testing-Machine.

600,000-Lb. Vertical Testing-Machine. Illustrated description of a machine of great capacity, built by a Philadelphia firm. 600 w. Engng—Feb. 16, 1906. No. 75284 A.

MEASUREMENT.

Indicator.

The Frahm Speed Indicator. W. C. Martin. Plate and description, with explanation of the action. 1000 w. Trans Inst of Engrs & Shipbuilders in Scotland —Feb., 1906. No. 75210 D.

POWER AND TRANSMISSION.

Bearings.

A Bearing for High-Speed Journals (Ein Lager für Hohe Zapfengeschwindigkeiten). F. Niethammer. Illustrating a bearing arranged to be lubricated by oil under pressure as designed for the turbo-dynamo of the Alioth Company, of Basel, Switzerland. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75120 D.

Variation of Pressure in Bearings Due to Eccentric Loading. Gives a diagram devised to show the effects upon bearings of eccentric loading or unsymmetrical supports. 600 w. Am Mach—Vol. 29, No. 8. No. 75236.

Cableway.

A New Design of Aerial Tramway. George K. Davol. Illustrates and describes a wire rope aerial tramway recently installed at the mines of the American Magnesite Co., in Santa Clara County, Cal., which has a length of a little more than half a mile, and a fall between terminals of 650 feet. 4400 w. Jour of Elec—Feb., 1906. No. 75057 C.

Clutches.

The Location and Use of Friction Clutches. W. H. Wakeman. Considers the benefits of friction clutches, presenting points in regard to their proper use. Ills. 3000 w. Am Mfr—Feb. 8, 1906. No. 74922.

Compressed Air.

Compound Air Compression. Lucius I. Wightman. Considers jacket cooling and intercooling, multistage compression, &c. 4200 w. Am Mach—Vol. 29, No. 5. No. 74818.

Derivation of Formulæ for Single and Stage Compression, also Proof of Conditions Governing Best Proportioning and Highest Economy in Stage Compression. Edward F. Schaefer. Shows how the formula for horse-power is developed. 1200 w. Sib Jour of Engng—Jan., 1906. Serial. 1st part. No. 74796 C.

Tests of Small Compressors. Max Kurth. Illustrated descriptions of complete methods used for determining the efficiencies of small air compressors running at high speeds. 2800 w. Mines & Min—Feb., 1906. No. 74935 C.

Cranes.

4-Ton Hydraulic Wharf Crane. Illustrated description of a crane being built for the Port of Antwerp. 500 w. Engng —Feb. 16, 1906. No. 75283 A.

The Electric Travelling Crane. States the advantages of electric cranes, and explains the methods of applying electricity, and the advantages of each. 2000 w. Elec Engr, Lond—Jan. 26, 1906. No. 74875 A.

Gears.

Designing Spiral Gears. F. J. Bostock. Explains a graphical method, without formulas and requiring as little knowledge of trigonometrical ratios as possible. 1700 w. Am Mach—Vol. 29. No. 4. No. 74824.

Some Special Forms of Inside and Outside Gears. Robert Sibley. Notes and formulas in regard to inside and outside gears with movable centers. 700 w. Am Mach—Vol. 29. No. 6. No. 74940.

Speed-Change Gears. A. M. Sosa. Illustrated examples of speed-change gearing, especially those that apply to feeds for machine tools. 1000 w. Am Mach—Vol. 29, No. 7. No. 75013.

Worm Contact. Robert A. Bruce. Calls attention to some of the more obvious omissions that have been overlooked in the experimental investigations of the actions involved in worm-gearing. Ills. 7500 w. Inst of Mech Engrs—Jan. 19, 1906. No. 74885 D.

Transporters.

Transporters in the Outer Harbor at Emden (Verladebrücken im Aussenhafen zu Emden). Illustrated description of two bridges and conveyors for transporting cargo between vessels and railways at Emden, on the North Sea coast of Germany. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75109 D.

Unloading.

Ore-Unloading by Machinery. Day Allen Willey. Many illustrations, with description of the new Hulett unloading apparatus recently placed in operation on the Great Lakes for unloading cargoes of ore and coal. 1200 w. Sci Am—Feb. 10, 1906. No. 74952.

STEAM ENGINEERING.

Boilers.

Steam Boiler Efficiencies. John B. C. Kershaw. Gives tests obtained under working conditions showing that gains in evaporative efficiency are possible, and describing devices and new forms of construction. 2000 w. Power—Feb., 1906. No. 74900 C.

Chimneys.

See Civil Engineering, Construction.

Draft.

Chimney Draft and Forced Draft. J. W. Richards. Considers methods of calculating the theoretical total suction of a chimney, illustrating by problems and solutions. 3500 w. Elec-Chem & Met Ind —Feb., 1906. No. 74911 C.

Engines.

Comparison Between Torpedo Boat and Merchant Marine Engines. Dr. Alfred Gradenwitz. An illustrated article comparing size, weight, &c., of engines of equal horse-power. 700 w. Sci Am Sup —Feb. 10, 1906. No. 74954.

Taking Care of an Engine. W. H. Wakeman. Calls attention to details the care of which will result in satisfactory service. Ills. 2000 w. Power—Feb., 1906. No. 74897 C.

Flow.

The Flow of Steam Through Nozzles. An experimental study, discussing in some detail the results obtained in Mr. Rosenhain's experiments, as given in the Pro. of the Inst. of Civ. Engrs. 4000 w. Engng—Feb. 2, 1906. No. 74993 A.

Governor.

The Williams Governor and Its Design. E. F. Williams. Illustrated description of a governor designed to operate light running, balanced valves at a speed variation of from 2 to 2½ per cent. 2000 w. Engr, U S A—Feb. 1, 1906. No. 74860 C.

Modern Plant.

An Efficient Modern Steam Plant in Flour-Mill Service. William H. Bryan. Reports an investigation made to ascertain the efficiency of a new power plant, and to compare with the results of the old plant, &c. Ills. 5500 w. Jour Assn of Engng Socs—Jan., 1906. No. 75098 C.

Slide Valves.

The Application of Calculating Charts to Slide-Valve Design. William J. Goudie. Gives calculating charts designed by the author, explaining their use. 4500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Dec. 19, 1905. No. 75209 D.

Smoke.

Presidential Address at the Conference on Smoke Abatement. Sir Oliver Lodge. Urging the conversion of coal into gas, and the piping to towns, not allowing the crude combustion of coal. 3400 w. Jour Roy San Inst—Feb., 1906. No. 75088 D.

Smoke Abatement. John B. C. Kershaw. A report on the London smoke abatement conference 3800 w. Cassier's Mag—Feb., 1906. No. 74921 B.

Steam Consumption.

The Steam Consumption of Reciprocating Engines. T. Stevens, and H. M. Hobart. A study of the dependency of the steam consumption on the admission pressure, the effect of the degree of vacuum on the steam consumption and the effect of superheat. 1500 w. Elec Wld—Feb. 17, 1906. No. 75041.

Steam Turbines.

The Economy of Steam Turbines Compared with that of Reciprocating Engines. T. Stevens and H. M. Hobart. A research investigating the operation of the steam turbine under various conditions, and its comparative qualities as related to the reciprocating engine. Also editorial. 2500 w. Elec Wld—Feb. 24, 1906. No. 75267.

The Evolution and Prospects of the Elastic Fluid Turbine. R. M. Neilson. Gives an historical review showing the progress made in utilizing elastic fluids other than air, with suggestions for future improvement. Discussion. 14500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Dec. 19, 1905. No. 75208 D.

The Regulation of Multi-Stage Steam Turbines (Die Regelung Mehrstufige Dampfturbinen). Harry Jansson. Describing a method of speed regulation by cutting out successive stages of the expansion, in steam turbines of the Parsons type. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75119 D.

Why the Steam Turbine Is Not More Efficient. R. M. Neilson. Discusses the losses in turbines, and how to reduce them. 1200 w. Power—Feb., 1906. No. 74898 C.

See Marine and Naval Engineering.

Stoking.

Mechanical Firing (Mechanische Feuerungen). Hr. Nies. Describing mechanical stokers in use in Germany, with especial reference to the production of a minimum amount of smoke. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75110 D.

Superheating.

Superheated Steam. Michael Longridge. A lecture at Bradford Tech. School. Gives an explanation of why superheated steam improves the economy of the steam-engine, and the principles on which a superheating plant should be designed. 10000 w. Engng—Feb. 2, 1906. No. 74873 A.

Thermodynamics.

Contributions to the Dynamics of Elastic Fluids (Beiträge zur Dynamik der Elastischen Flüssigkeiten). Dr. A. Fliegner. An examination of the modifications in the flow of steam and gases from nozzles, due to the elasticity of the fluid. Two articles. 3500 w. Schweiz Bauzeitung—Jan. 20, 27, 1906. No. 75124 each B.

MISCELLANY.

Aeronautics.

A Proposed Solution of the Problem of Flight. Franz Pabisch. Translated from *Stein der Weisen.* Illustrated discussion of several flying machines, and their ability to satisfy necessary conditions. 1000 w. Sci Am Sup—Feb. 10, 1906. No. 74956.

The Alighting of Aeroplanes (Sur l'Atterrissage des Aeroplanes). M. Bouquet de la Grye. Describing the application of a horizontal plane above the supporting surfaces, to enable the machine to maintain its equilibrium during the descent. 800 w. Comptes Rendus—Jan. 15, 1906. No. 75115 D.

The Helicoptere: Santos-Dumont's Latest Flying Machine. L. Ramakers. Illustrated description of a machine in course of construction. 1300 w. Sci Am—Feb. 10, 1906. No. 74951.

Analysis.

A Graphic Method of Harmonic Analysis. J. Harrison. Describes a graphical process for the harmonic analysis of cyclical functions, explaining the method. Diagrams. 1200 w. Engng—Feb. 16, 1906. No. 75282 A.

Card Index.

The Application of Card Index Systems to a Motive Power Office. J. H. Wynne. Gives sample cards used, explaining their convenience. 1200 w. Ry Mas Mech—Feb., 1906. No. 74826.

History.

The Changes of One Lifetime in the Machine Shop. Egbert P. Watson. An account of the experience of the author in connection with the advance in materials, shop methods, and machine tools during the past fifty years. 3500 w. Engineering Magazine—March, 1906. No. 75167 B.

Laundry Machinery.

The Technology of Laundry Machinery (Die Technischen Hülfsmittel der Mechanischen Wäschereinigung). G. Rohn. With numerous illustrations of machines for the various laundry operations, and a bibliography of works upon the subject. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 10, 1906. No. 75108 each D.

Oxygen Flasks.

The Explosion of Oxygen Flasks (Ueber Sauerstoffflaschen-Explosionen). R. Nowichi. An account of the bursting of cylinders of compressed oxygen, showing such occurrences to be due to the presence of hydrocarbons, or to defective valve construction. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 20, 1906. No. 75134 D.

MINING AND METALLURGY

COAL AND COKE.

Breaker.

The Truesdale Breaker. Illustrated description of a new breaker and washery, designed to handle an output of four thousand tons per day. 4000 w. Mines & Min—Feb, 1906. No. 74930 C.

Briquettes.

Some Notes on Fuel Briquetting in America. Clarence M. Barber. Considers the use of briquettes in Europe, their manufacture and the materials used, and the introduction of the industry in America. 3000 w. Jour Assn of Engng Socs—Jan. 1906. No. 75099 C.

California.

California's New Coal Fields. Clarence E. Edwords. Information concerning the bituminous deposits recently discovered and their value. 1700 w. Min Wld—Feb. 17, 1906. No. 75050.

Coal Storage.

Coal-Storage Bunker and Band Conveyor for the Bargold and New Tredegar Collieries. Illustrates and describes the coal-bunker and steel-structural work at the Bargold colliery; and the improved band-conveyor recently installed at the New Tredegar colliery in South Wales. 2000 w. Engng—Jan. 26, 1906. No. 74893 A.

Coke.

Caking Fine Coal for Coking. Alfred Ernst. Considers the advantages of stamping and compacting at by-product ovens. 3000 w. Ir Age—Feb. 22, 1906. No. 75227.

Coke Oven.

Modern Features of the United Otto Coke Oven. Illustrated description extracted from a recently issued pamphlet. 2000 w. Ir Age—Feb. 22, 1906. No. 75-226.

Coke Plant.

The Colonial Coke Co.'s Plant. Illustrated detailed description of a plant in the region commonly known as the Lower Connellsville district. The mine turns its output into coke. 1700 w. Eng & Min Jour—Feb. 3, 1906. Serial. 1st part. No. 74838.

Firedamp.

Safety Lamp Gauzes and Flame Tests for Firedamp. J. Ashworth. Reports extensive experiments and tests made on a variety of lamps in the present number. Ills. 2000 w. Ir & Coal Trds Rev—Jan. 26, 1906. Serial. 1st part. No. 74884 A.

Pittsburg.

Banning No. 2 Mine. Illustrated description of this coal mine near Pittsburgh, especially its system of endless rope haulage. 1400 w. Eng & Min Jour—Feb. 17, 1906. No. 75040.

Review.

Coal Mining in 1905. E. W. Parker.

Gives details of production from the various coal districts of the United States, showing great activity. 2400 w. Min. Wld—Jan. 27, 1906. No. 74776.

COPPER.

Arizona.

Arizona. An illustrated article reporting the different districts. Gains of thirty-six million pounds of copper are given over the previous year. 6500 w. Min Wld. Jan. 27, 1906. No. 74784.

Australia.

The Wallaroo and Moonta Mines. L. Hancock. Information concerning these copper mines of South Australia, and their operation. 700 w. Eng & Min Jour —Feb. 10, 1906. No. 74942.

Copper Trade.

See Industrial Economy.

Refinery Plant.

Copper Refinery Plant for Martin's Direct Rolling Process. H. J. Martin. Plan and description with summary of advantages. 2500 w. Foundry—Feb. 1906. No. 75207.

Volumetric Method.

A New Volumetric Method for Copper and the Ores of Copper. Alfred Adair. The method is based on the precipitation of sub-sulphocyanide of copper from its solutions under conditions which have been found to give constant results. 2000 w. Jour Chem, Met & Min Soc of S. Africa—Dec., 1905. No. 75079 E.

Works.

The Nichols Copper Works. O. Perfahl. Translated from *Zeit. f. Berg-, Hütten u. Salinenwesen.* Brief description of extensive works at Laurel Hill, Long Island, N. Y., where crude copper, containing precious metals, is refined by electrolysis on the series system. 800 w. Eng & Min Jour—Feb. 17, 1906. No. 75036.

GOLD AND SILVER.

Assay Values.

Computation of Assay Values. William Crosley. Read before the Inst. of Min. & Met. Discusses the accuracy of methods of computing values for deposits varying greatly in shape and richness. 2500 w. Mines & Min—Feb., 1906. No. 74936 C.

Australia.

Gold Mining in Western Australia. John Plummer. Brief report with discussion of the cause of a decline in production during the past two years. 800 w. Min Wld—Jan. 27, 1906. No. 74781.

Cyanide Process.

Gold Molecules in Solution. G. T. Beilby. A study of the problems of solution as shown in the practice of the cyanide process of gold evtraction. 2500 w. Sci Am Sup—Feb. 17, 1906. No. 75030.

Desert-Mining.

A Southern California Desert Mining. Kirby Thomas. An illustrated account of the exploring and opening up of these desert regions. 2500 w. Min Wld—Feb. 3, 1906. No. 74844.

Dredging.

A New Gold Dredge. George L. Hurst. Illustrated description of a new dredge recently built at El Dorado, on the American River. Dredging is possible to a total depth of 50 ft. 1500 w. Min & Sci Pr—Jan. 27, 1906. No. 74847.

The Prospecting and Valuing of Dredging Ground. Norman C. Stines. Describes the prospecting of gravel deposits by means of the Keystone drill, to test their fitness for dredging purposes. Ills. 2000 w. Min & Sci Pr—Feb. 3, 1906. Serial. 1st part. No. 74967.

Filter-Press.

Filter-Press Practice in Western Australia. A. B. Wallace. Illustrates and describes this method of treating gold-bearing slimes. 1200 w. Min & Sci Pr—Feb. 3, 1906. No. 74968.

Gold Mines.

Gold Mines of the World. Abstracts and extracts from J. H. Curle's book, by Prof. Arthur Lakes. An illustrated review of the principal gold mines and mining regions. 6000 w. Mines & Min—Feb, 1906. No. 74932 C.

Idaho.

The Bullwhacker Mine, near Hailey, Idaho. A. Lakes. Illustrates and describes the geology of this mine and its deposits of lead-silver ore. 1200 w. Min Rept—Feb 15, 1906. No. 75046.

Ore Deposits.

The Ore Deposits of the Ontario Mineral Belt. Walter P. Jenney. Describes the geology of this vein in Utah, and the deposits of silver-lead ore, with other minerals. 4000 w. Min & Sci Pr—Feb. 17, 1906. No. 75254.

Production.

Gold and Silver Production of the World. Charles C. Schnatterbeck. A review of the past year showing a phenomenal growth in the gold output, and giving information concerning the United States, and foreign countries. 3500 w. Min Wld—Jan. 27, 1906. No. 74775.

Queensland.

Black Ridge, Clermont. Lionel C. Ball. Recent notes given as a supplementary report to an earlier article. Deals with the geology, mining and milling, claims, &c. Ills. 8500 w. Queens Gov Min Jour —Dec. 15, 1905. Serial. 1st part. No. 74867 B.

Reduction.

Ore Reduction at the Sons of Gualia Mine. Robert Allen. Describes the treatment of this gold ore of Australia. The ore is a chloritic schist, with lenses of quartz, calcite and gypsum showing occasionally. It is extremely simple to treat being recovered mainly by battery treatment, followed by cyanide treatment ot the sands, and roasting and cyanide treatment of the concentrates. Ills. 4000 w. Min Jour—Feb. 17, 1906. No. 75279 A.

Sampling.

The sampling of Base Bullion. John W. Root. Read before the W. Assn. of Tech. Chem. & Met. Briefly considers the methods in use, and those formerly employed. 1800 w. Min Rept—Feb. 8, 1905. No. 74964.

Silver.

Early Silver Production in Mexico and Its Fluctuations. F. J. H. Merrill. Information concerning the production and its variations. 900 w. Eng & Min Jour —Feb. 24, 1906. No. 75258.

South Dakota.

The Early History of Black Hills, South Dakota. W. H. Storms. Begins an interesting review of this important gold-mining district. 1800 w. Min Wld—Feb. 17, 1906. Serial. 1st part. No. 75048.

Sulphides.

Cerro Gordo. C. H. Laidlaw. Gives history and illustrated description of this California mine. The metals are usually combinations of sulphides and their oxides, carrying gold, silver and copper. 2500 w. Min Rept—Feb. 15, 1906. No. 75045.

Tailings.

Tailing Disposal of Gold Dredges. J. P. Hutchins. Reviews the history of tailing disposal and the methods that have been tried to restore worked out land to its original condition. Ills. 3800 w. Eng & Min Jour—Feb. 3, 1906. No. 74836.

Transvaal.

Van Ryn Gold Mines Estates, Limited. Address of F. A. Gillam at the annual meeting, reviewing the conditions of these mines in South Africa. Ills. 2700 w. Min. Jour—Feb. 3, 1906. No. 74991A.

IRON AND STEEL.

Alloy Steels.

See Mechanical Engineering, materials.

Blast Furnaces.

The Removal of a Salamander from a Blast Furnace. John J. Smith. An illustrated article. Describes the construction of the furnace, the formation of the salamander, and the operations necessary in removing; also the extent of injury to the furnace. 5300 w. Am Mach—Vol. 29. No. 8. No. 75233.

Blowholes.

The Formation of Blowholes in Steel Ingots (Ueber die Bildung von Hohlräumen in Stahlblocken). J. Riemer. A discussion of the causes of blowholes and piping in steel ingots, and the defects which follow in forgings and other products. 3000 w. Stahl u Eisen—Feb. 15, 1906. No. 75138 D.

Carbon Determination.

The Determination of Carbon in Ferrochrome and the Eimer Carbon Crucible. C. Offerhaus. The writer compares some direct methods with each other and with Wochler's chlorine method, and gives a short account of his determinations. The Eimer crucible is illustrated and described. 1600 w. Elec Chem Met Ind—Feb., 1906. No. 74912 C.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Mesaba.

The Western Mesaba Iron Range. Dwight E. Woodbridge. Map and information concerning the mineral wealth of township 56, range 24. 1500 w. Ir Age—Feb. 1, 1906. No. 74788.

Rail Mill.

New Rail Mill of Dominion Iron and Steel Company, Limited, Sydney, Cape Breton. An illustrated description of a modern installation. 2500 w. Can Engr—Feb, 1906. No. 74840.

Rolling Mills.

New Types of Rolling Mill Gearing. Abstract of a paper by Director Ortmann before a meeting of the Assn. of Ironmasters in South-West Germany and Luxemburg. Illustrates and describes types of gearing, and discusses the cost of motive power. 2500 w. Ir & Coal Trds Rev—Feb. 9, 1906. No. 75223 A.

Some Notes on Modern German Rolling Mills. Illustrates and describes types of modern mills used in Germany and their working and arrangement. 3000 w. Ir & Coal Trds Rev—Jan. 26, 1906. Serial. 1st part. No. 74881A.

The Electric Driving of Rolling-Mill Trains (Elektrischer Antrieb von Reversierwalzenstrassen). F. Weideneder. A comparison of the driving of rolling mills by electric motors with the use of steam engines, using the exhaust steam to operate low-pressure steam turbines. 1800 w. Stahl u Eisen—Feb. 1, 1906. No. 75135 D.

Russia.

A New Iron works in Russia (Ein Neues Russisches Hochofenwerk). Ferd. Heck. A review, with tables and diagrams, of the iron production of Russia, with especial reference to the development of the Tscherdinsk district, in the Government of Perm, between the Unja and Perwokamennoi rivers. 3000 w. Stahl u Eisen——Feb. 15, 1906. No. 75139 D.

Talbot Process.

The Talbot Continuous Steel Process and its Benefits in Steel-making. G. A. Wilson. Describes the working of this process at the Cargo Fleet works, of Middlesbrough. 2500 w. Ir & Coal Trds Rev—Feb. 16, 1906. No. 75292 A.

MINING.

Alaska.

Alaska. Alfred H. Brooks. Presented at the El Paso meeting of the Am. Min. Cong. The mineral production of the past year shows a remarkable increase over 1904. Ills. 3000 w. Min. Wld—Jan. 27, 1906. No. 74783.

Blasting.

Arrangement for Electric Spitting of Fuses in Shaft Blasting. J. A. Clay. Illustrates and describes an arrangement for igniting the fuses by electricity, to secure greater safety in shaft-sinking. 600 w. Min Rept—Feb. 15, 1906. No. 75047.

Colorado.

Colorado. Kirby Thomas. Reports increased production in all districts with gratifying prospects for 1906. Ills. 10000 w. Min Wld—Jan. 27, 1906. No. 74785.

Concentration.

Mill Experiences. R. D. O. Johnson. An illustrated study of the problem of diminishing the excessive wear on all the parts of a concentrating mill. 1700 w. Eng & Min Jour—Feb. 17, 1906. No. 75038.

The Acme Combined Concentrating Table. L. H. L. Huddart. Illustrated description of a table intended for the treatment of metalliferous slimes, with report of a trial. 1500 w. Min Rept—Feb. 1, 1906. No. 74833.

Drainage.

Mine Drainage at the extreme acidity of the waters and the troubles due to this cause, illustrating and describing pumps used. 2500 w. Min & Sci Pr—Feb. 10, 1906. No. 75043.

Filling.

The Hydraulic Filling of a Coal Seam at Lens, Pas de Calais, France. Lionel E. Hill and Malcolm Burr. Read before the Inst. of Min. & Met. An illustrated description of the process as adapted to the collieries at Lens. 3500 w. Ir & Coal Trds Rev—Feb. 16, 1906. No. 75291 A.

Haulage.

The Application of the Mono Rails in Underground Tramming at the Langlaagte Deep. Wager Bradford. A brief description, with illustrations, of a successful installation of a mono rail system of motor traction, suspended from the roof. 5000 w. Jour S African Ass'n of Engrs—Dec., 1905. No. 74866 F.

Lighting.

Electric Lighting in Subterranean Workings (Elektrische Beleuchtung an Füllörtern und in Strecken unter Tage). E. Anders. A general description of underground electric lighting appliances in accordance with the official mining regulations of Germany. 4000 w. Glückauf—Feb. 3, 1906. No. 75133 B.

Manganese.

The Demand for Manganese Ores. W. Venator. Translated from *Stahl und Eisen*. Reviews the growing importance of these ores and the industry of mining them, the difficulties, and related subjects of interest. 2800 w. Min Jour—Feb. 10, 1906. Serial. 1st part. No. 75083 A.

Methods.

Mining Methods. W. H. Storms. Specially referring to mining practice in California. 1200 w. Min & Sci Pr—Feb. 10, 1906. Serial. 1st part. No. 75044.

Mine Telephones.

Telephone Lines in Coal Mines. C. M. Means. Some suggestions for the construction of these underground lines. 1200 w. Eng & Min Jour—Feb. 24, 1906. No. 75256.

Mining Law.

Amendments to Federal Mining Law. R. S. Morrison. Read before the Min. Cong. at El Paso. Discusses some of the points in which the present law is unsatisfactory. 1500 w. Mines & Min—Feb, 1906. No. 74931 C.

The New Queensland Mining Bill. Gives an outline of the bill before the Legislative Assembly, which aims to remedy certain defects and supply shortcomings in the present Mining Act. 7500 w. Queens Gov Min Jour—Dec. 15, 1905. No. 74868 B.

The U. S. Supreme Court and the U. S. Mining Law. R. W. Raymond. General remarks, with a notice of the "Stemwinder" and "Bunker Hill" cases. 2000 w. Eng & Min Jour—Feb. 10, 1906. No. 74941.

Montana.

Montana. Reports of prosperity of metal mining enterprises throughout the state. 11000 w. Ills. Min Wld—Jan. 27, 1906. No. 74786.

Motive Power.

Motive Power in Mines. C. H. Caruthers. Briefly refers to the use of animals, and rope haulage in mines, and considers haulage by steam, compressed air and electric locomotives. Ills. 2000 w. R R Gaz—Vol. XL. No. 5. No. 74822

Operation.

Electricity vs. Compressed Air for Mine Operation. Edward F. Schaefer. Discusses the advantages of each but considers compressed air far superior as a driving fluid. 2000 w. Sib Jour of Engng—Feb., 1906. No. 75271 C.

Ore Deposits.

Block-Faulting, and Its Relation to Ore Deposition. Walter P. Jenney. An explanation of this singular type of fault-structure and the causes, and the ore deposits in association. 3200 w. Min & Sci Pr—Jan. 27, 1906. No. 74845.

Ore Dressing.

Ore Dressing by Flotation. An account of two recent papers before the Faraday Society. One by James Swinburne and Dr. G. Rudorf, and the other by Prof. A. K. Huntington. Discusses the successful application of this process to the treatment of tailings, its theory, &c. 4000 w. Elec. Chem & Met Ind—Feb., 1906. No. 74909 C.

Ore Handling.

Underground Mechanical Transport in the Witwatersrand. An illustrated article describing methods of dealing with particular cases, and explaining the difficulties in the way of a complete solution. 2500 w. Engr., Lond—Feb. 2, 1906 No. 74998 A.

Ore Treatment.

Successful Treatment of Refractory Ores. Eric Hedburg. Explains the depreciation in value of ores containing zinc, iron, copper and nickel, the difficulty in separating, and the final discovery of a means of successfully treating them so as to recover all values. Ills. 1800 w. Min Wld—Feb. 10, 1906. No. 74965.

Philippines.

Mining in the Philippines. Oscar Halvorsen Reinholt. An illustrated article reporting the present condition of the mining industry. Coal, gold and ores of iron and copper are the most important products. 1500 w. Min Wld—Jan. 27, 1906. No. 74782.

Pneumatic Tools.

Air Hammer Rock Drills in Mining. Edward A. Rix. Read at convention of Cal. Miners' Assn. Gives the history of the introduction, and information in regard to its practical application and advantages. 6000 w. Compressed Air—Jan. 1906. No. 74793.

Production.

The Mineral and Metal Production of the United States in 1905. General remarks with review of both non-metallic and metallic products. Table. 3000 w. Min Wld—Jan. 27, 1906. No. 74774.

Rare Minerals.

Rare Minerals in 1905. Charles C. Schnatterbeck. Gives information concerning tungsten, molybdenum, vanadium, uranium, rutile, monazite, gadolinite, zirconia, tantalite, columbite, osmium, and lithium minerals. 2500 w. Min Wld—Jan. 27, 1906. No. 74779.

Respiration Apparatus.

Respiration Apparatus for Colliery Rescue Work. Profs. M. Bamberger, and F. Böck. Abridged translation from an article in *Glückauf.* Remarks on types of apparatus tried and their defects, with illustrated description of improved apparatus constructed by the authors. 3000 w. Col Guard—Feb. 2, 1906. Serial. 1st part. No. 74992 A.

Separation.

The Separation of Iron from Zinc by Ammonia. Kurt Pietrusky. Gives report of experimental investigations, showing that satisfactory results can only be obtained when there is a large excess of ammonia in the solution. 1500 w. Min & Sci Pr—Feb. 3, 1906. No. 74969.

Shafts.

Gallows Frames for shafts. R. D. O. Johnson. Illustrates and describes a guyed design erected by the writer, and also a proposed design of even greater economy in material. 500 w. Eng & Min Jour—Feb. 24, 1906. No. 75257.

Shaft Sinking.

Modern Methods in Shaft Sinking. James Tonge. Considers improvements for handling buckets, sinking with drums, coffering, and the freezing process. Ills. 2500 w. Mines & Min—Feb., 1906. Serial. 1st part. No. 74934 C.

Smelting.

Smelting Zinc Retort Residues. E. M. Johnson. Abstract of a paper in the *Western Chemist & Metallurgist.* A report of experimental work carried out in Kansas. 800 w. Eng & Min Jour—Feb. 17, 1906. No. 75037.

The Smelting Works of British Columbia. Notes on the changes and improvements made at the various smelters during the year 1905. Ills. 3000 w. B. C. Min Rec—Dec., 1905. Serial. 1st part. No. 74790 B.

Steam Shovel.

The Allis-Chalmers Steam Shovel. W. N. Tanner. Illustrates and describes a type found useful in mining operations. 1000 w. Eng & Min Jour—Feb. 3, 1906. No. 74837.

Surveying.

Anderson's Method for Passing a Survey Line Down a shaft. Describes tne method, giving diagrams. 500 w. Min & Sci Pr—Feb. 3, 1906. No. 74966.

Timbering.

Systematic Timbering at Emley Moor Collieres. H. Baddiley. Illustrates and describes an improved system of timbering with the view of diminishing accidents from falls of roof and sides. 1000 w. Eng & Min Jour—Feb. 17, 1906. No. 75039.

Transvaal.

Transvaal Mining in 1905. Ralph Stokes. An illustrated historical review of the mines and minerals of this district. 5000 w. Min Wld.—Jan. 27, 1906. No. 74780.

Valuation.

The Valuation of Mineral Properties. T. A. O'Donahue. A discussion of the conditions which differ from the valuation of other properties, giving formula deduced to comply with these conditions. 2500 w. Col Guard—Feb. 9, 1906. No. 75078 A.

Ventilation.

Mechanical Mine Ventilation. J. R. Robinson. Read before the Coal Min. Inst. of America. A comparison of various types of fans, the Guibal, Screw Propeller, "Sirocco," Capell, and Robinson. 4000 w. Mines & Min—Feb., 1906. No. 74-933 C.

MISCELLANY.

Antimony.

The West Gore Antimony Deposits. Alex. McNeil. Information concerning this mine in Nova Scotia, its history and development. The deposits are antimony-gold ore. 1500 w. Can Min Rev—Feb. 1906. No. 75225 B.

Coal-Dust Firing.

Coal-Dust Firing of Reverberatory Matt Furnaces. B. Severin. Sörensen. Notes on some experiments made at Murray, Utah, which gave results considered satisfactory. Ills. 1500 w. Eng & Min Jour—Feb. 10, 1906. No. 74944.

Lead.

Methods for the Fire Assay of Lead. Oscar J. Frost. From *Jour. W. Assn. of Tech. Chem. Met.* Describes an operation applicable to a comparatively long fusion with gradually rising temperature. 3000 w. Min Wld—Feb. 17, 1906. No. 75051.

Metallography.

Cooling Curves of Metallic Solutions. Thomas T. Read. Considers the causes of points of inflection in a cooling curve. 1000 w. Ir & St Mag—Feb., 1906. No. 75096 D.

Oil.

The California Oil Fields and Oil Fuel for Locomotives. D. A. Willey. An illustrated account of the development of this field, and the substitution of oil for solid fuel on locomotives, with results. 1200 w. Ry Age—Feb. 23, 1906. No. 75-250.

Quicksilver.

California Quicksilver Industry. Clarence E. Edwords. Historical review of the development and production. Ills. 1600 w. Min Wld—Feb. 24, 1906. No. 75253.

The Mercury Deposits of Mexico. F. J. H. Merrill. Information concerning these deposits, their development and value. 2000 w. Min Wld—Feb. 17, 1906. No. 75049.

Tin.

The Tin Industry in 1905. A review of production and prices, and matters of interest relating to this industry. 2000 w. Min Wld—Jan. 27, 1906. No. 74778.

Zinc.

The Palmerton Works of the New Jersey Zinc Company. O. Pufahl. Translated from *Zeit. f. Berg-, Hutten- und Salinenwesen.* Brief description of the oxide works, spiegeleisen blast furnace, spelter works, lithopone works, and sulphuric acid works. 1200 w. Eng & Min Jour—Feb. 10, 1906. No. 74943.

Zinc Mining in 1905. A review of the progress made towards utilizing the zinc resources of British Columbia. Ills. 1700 w. B C Min Rec—Dec., 1905. No. 74-789 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Baggage.

Baggage Service in the United States. E. Giese and Blum, in *Zeitung des Vereins.* An explanation of the system in use in America for forwarding baggage. 7700 w. Bul. Int Ry Cong—Jan., 1906. No. 75220 E.

Car Movements.

Beecham Car Transcribing System. Describes the system of car records used on the C., M., & St. P. Ry., and recently adopted by other roads. Its principal advantage is the ease with which information may be obtained concerning any car. 3500 w. R R Gaz—Vol. XL. No. 5. No. 74821.

Fares.

Required Reduction of Passenger Fares in Ohio. Extracts from a document prepared by James McCrea to show why passenger fares should not be arbitrarily reduced to two cents a mile in the State of Ohio. 4500 w. R R Gaz. Vol XL. No. 7. No. 75023.

Fast Express.

The Cote d'Azur Rapide. An illustrated account of the first-class passenger express which runs between Paris and the Mediterranean in half a day. 1000 w. Engr., Lond—Feb. 16, 1906. No. 75281 A.

Freight.

In Relation to the Transportation Problem. W. M. Prall. Principally a discussion of freight transportation and its problems. General discussion follows. 9000 w. Pro Ry Club of Pittsburgh—Nov., 1905. No. 75097 C.

Some Ideas in Handling and Tracing High Class Freight. W. B. Harrison. Paper and discussion aiming to simplify the tracing of delayed freight. 3500 w. Pro Iowa Ry Club—Dec. 8, 1905. No. 74795 C.

Italy.

The Government Railroad Monopoly in Italy. The first of a series of articles discussing this subject. 1200 w. R R Gaz—Vol. XL. No. 8. No. 75241.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

New W. A. B. Equipment. The first of a series of illustrated articles which will describe the Westinghouse new air brake equipment for all classes of engines and cars now in use. 1700 w. Ry & Loc Engng—Feb., 1906. Serial. 1st part. No. 74857 C.

Card Index.

The Application of Card Index Systems to a Motive Power Office. J. H. Wynne. Explains the advantages of the card system for railway office records. Also discussion. 6400 w. Pro W Ry Club—Jan. 16, 1906. No. 75224 C.

Cars.

High-Capacity Wagons for Belgium Railways. Illustrates and describes a 35-ton hopper ore-wagon, and a 40-ton wagon for transport of rails, shown at the Liége exhibition. 500 w. Engng—Jan. 26, 1906. No. 74894 A.

New Bogie Transport Cars. Brief illustrated description of cars recently constructed for the transport of steam plowing engines, or similar machines. 300 w. Sci Am Sup—Feb. 17, 1906. No. 75027.

Second-Class Carriage for the International Express Service. Illustrated description of a car designed to seat a larger number of passengers than usual, without increasing the weight of the vehicle. 300 w. Engng—Feb. 9, 1906. No. 75072 A.

The American Palace Car "Columbia." Illustrates and describes the operating mechanism of a combination parlor car and sleeping car. The berths are stored beneath the floor. 800 w. Ry Mas Mech—Feb, 1906. No. 74827.

Thirty-five Ton Steel Gondola Cars for the Natal Government Railways. Brief illustrated description of high-sided gondolas for coal traffic. 300 w. Ry Age—Feb. 2, 1906. No. 74835.

Draft Gear.

Functions of a Good Draft Gear. A. Stucki. Considers the functions in detail, and urges simplicity of construction. 2500 w. R R Gaz—Vol. XL. No. 8. No. 75237.

Electric Locomotive.

Operation of Electric Locomotive During a Snowstorm. An illustrated account of a very interesting test made of one of the N. Y. C. electric locomotives, near Schenectady, N. Y., during a severe snowstorm. 1200 w. R R Gaz—Vol. XL. No. 7. No. 75022.

Locomotive Tests.

Record of the Pennsylvania Locomotive Tests. Editorial review of the final record of the tests made at the Louisiana Purchase Exposition, giving the summary of conclusions. 2000 w. R R Gaz—Vol. XL. No. 6. No. 74946.

The Tests of Locomotives at the St. Louis Exhibition, 1904. Gives some of the special features of these tests, for purposes of comparison, with general information of interest. Also editorial. 6000 w. Eng News—Feb. 15, 1906. No. 75017.

Locomotives.

Atlantic Type Locomotives in Germany. Charles S. Lake. Illustrates types in use, and gives information of interest concerning them. 1400 w. Mech Engr—Feb. 3, 1906. No. 74984 A.

Compound Express Locomotive, G. N. R. Particulars and engravings of this engine, with 2-page supplement. 600 w. Engr., Lond—Jan. 26, 1906. No. 74891 A.

Decapod Locomotive for Mountain Grades on the Argentine Great Western Railway. Illustrated description of an engine designed to meet special conditions, and to operate on stretches of track where the rails are only of moderate weight. 700 w. Ry Age—Feb. 9, 1906. No. 74959.

Delaware & Hudson Locomotives with Young Valves and Gear. Illustrates and describes locomotives (4-6-0) intended for fast-freight service. 500 w. R R Gaz—Vol XL. No. 5. No. 74819.

De Pambour on Locomotive Engines. Concerning a valuable book published 70 years ago, and an account of how his information was obtained. 4000 w. Engr., Lond—Feb. 9, 1906. No. 75065 A.

Four - Cylinder Compound Locomotive for the Paris-Orleans Railway. Illustrations and dimensions. 400 w. Engng—Feb. 2, 1906. No. 74994 A.

French Compounds on the Great Western Railway. Charles Rous-Marten. A report of the performance of the two new locomotives of the du Bousquet-de Glehn "Atlantic" design, intended for the heaviest and fastest express duty. 4800 w. Engr., Lond—Feb. 2, 1906. No. 74997 A.

Heavy Banking Locomotive, Belgian State Railways. Illustrates and describes a very powerful four-cylinder duplex locomotive, closely imitating the Mallet system, built to assist trains up inclines. 1000 w. Engr., Lond—Feb. 2, 1906. No. 74999 A.

Light Locomotives and Small Trains (Leichte Lokomotiven und Kleinzüge). Hermann von Littrow. Illustrating several designs of small locomotives for special and local service on branches of the Austrian State Railways. 2000 w. Glasers Annalen—Feb. 15, 1906. No. 75140 D.

Links in the History of the Locomotive. Information concerning "The Novelty" engine, with illustrations. Also describes the "William the Fourth" locomotive. 2500 w. Engr., Lond—Jan. 26, 1906. No. 74888 A.

Locomotives with Flexible Wheel Base (Kurvenbewegliche Lokomotiven). E. Metzeltin. Illustrating and describing a 100-ton compound locomotive of the Mallet-Rimrott type for the Northern Railway of France. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75107 D.

Monon Passenger 4-6-2. Illustrated description of a new Pacific type passenger engine. 800 w. Ry & Loc Engng—Feb., 1906. No. 74858 C.

Powerful Six - Coupled Locomotives. Charles S. Lake. Illustration, with description of a 6-wheel coupled bogie, or 4-6-0 type of locomotive recently introduced on the Great Southern and Western Railway (Ireland). 800 w. Mech Engr—Feb. 10, 1906. No. 75082 A.

Tank Locomotives for the New South Wales Government Railways. Illustrated description of a six-coupled double-bogie tank engine specially designed for heavy suburban passenger service. 400 w. Engng—Feb. 14, 1906. No. 75290 A.

Motor Cars.

Rail Motor Carriage. A. F. Sinclair. Illustrated description of Cochran's steam motor as used on the Great North of Scotland railway. 700 w. Ry & Loc Engng—Feb., 1906. No. 74856 C.

The Strang Gasolene-Electric Rail Motor Car. Illustrated description of an experimental car now on trial. 800 w. R R Gaz—Vol. XL. No. 8. No. 75242.

Superheater.

Vaughan-Horsey Superheater. Illustrates and describes a new type of superheater being tested by the Canadian Pacific Railway. 1000 w. Am Engr & R R Jour—Feb., 1906. No. 74850 C.

Tractive Power.

Tests on the Tractive Power of Locomotives (Untersuchungen über die Zugkraft von Lokomotiven). Dr. Rudolf Sanzin. A comparison of drawbar tests at high speeds upon various European and American lines, plotting the results in curves. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1906. No. 75105 D.

Train Lighting.

Appendices to the Report No. 2 on the Question of Lighting, Heating and Ventilation of Trains (Subject IX for Discussion at the Seventh Session of the Railway Congress). Cajetan Banovits. The report appeared in this publication in April, 1905. 24 tables and figs. 235 pages. Bul Int Ry Cong—Jan., 1906. No. 75221 E.

The Leitner-Lucas System of Train-Lighting. An illustrated description of apparatus for the electric lighting of trains, which has recently been tested on the Great Western Railway, England. 2000 w. Engng—Feb. 16, 1906. No. 75287 A.

Valve Motion.

Joy's Valve Motion. Illustrated description of a radial motion that is popular on British railways and in Japan. 1000 w. Ry & Loc Engng. Feb., 1906. No. 74855 C.

Wheels.

Turning Driving Wheels. Gustave Giroux. An illustrated article explaining in detail the steps taken to increase the output at the Angus shops of the Canadian Pacific Ry. 2200 w. Am Engr & R R Jour—Feb., 1906. No. 74852 C.

NEW PROJECTS.

Canada.

Canada's New Railways. A review of recent work accomplished and proposed. Map. 2200 w. Engr., Lond.—Feb. 9. 1906. No. 75068 A.

Philippines.

Horseback Inspection of the Philippine Railroad Projects. L. E. Bennett. An illustrated narration of some of the writer's experiences. 2500 w. R R Gaz—Vol. XL. No. 8. No. 75239.

Switzerland.

New Railway Projects in Switzerland (Neue Schweizerische Eisenbahnprojekte).

Dr. R. Moser. A discussion of proposed communications over the Eastern Alps, comparing the tunnel routes by way of the Greina Pass and the Splügen Pass. Two articles. 4500 w. Schweiz Bauzeitung—Feb. 3, 10, 1906. No. 75126 each B.

PERMANENT WAY AND BUILDINGS.

Constructor.

Notes on American Permanent Way Construction (Einige Bemerkungen über den Oberbau Amerikanischer Bahnen). E. Giese. A general description of the track construction of American railways, including road bed, rails, sleepers, and joints. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75100 D.

Railroad Construction Classification—Construction Expenses and Construction Record. Charles Hansel. Gives a subdivision of the classification of construction expenses as set forth by the Interstate Commerce Commission, providing a close analysis which may be extended. 3500 w. Ry Age—Feb. 23, 1906. No. 75252.

Dust.

The Prevention of Dust on Roads and Railway Tracks by Sprinkling with "Westrumite." Describes this petroleum product, which has been used in Europe and is being introduced in America, giving its advantages, disadvantages and cost. 1600 w. Eng News, Feb. 22, 1906. No. 75246.

Railroad Engineering.

The Division Engineer. Discusses experiences occurring in railroad work. dealing in the present number with maintenance work. 1200 w. R R Gaz. Vol XL. No. 6. Serial. 1st part. No. 74948.

Railroad Offices.

General Features and Foundation Details, New Office Building, New York Central Lines. An illustrated description of an important and interesting building to be built in connection with the improvements at the New York terminal. 2500 w. Eng Rec—Feb. 24, 1906. No. 75-262.

Shops.

New Locomotive and Car Shops of the Louisville and Nashville Ry. Illustrated description of the new shops at South Louisville, Ky. 2000 w. Eng. News—Feb. 8, 1906. No. 74914.

Signalling.

Progress in the Use of the Block System. Gives a table of statistics of railroad lines in the United States on which the block system is in use, with explanations. 2200 w. R R Gaz—Vol. XL. No. 5. No. 74820.

Station.

The Pennsylvania Station in New York. Illustration, and plans at different levels, and cross-section profiles, with descriptive notes. 1000 w. R R Gaz—Vol. XL. No. 6. No. 74947.

Surveying.

See Civil Engineering, Measurement.

Terminals.

East Altoona Freight Locomotive Terminal. This large locomotive terminal of the Pennsylvania railrooad is illustrated and described. 1800 w. Am Engr & R R Jour—Feb., 1906. Serial. 1st part. No. 74851 C.

Recommendations of the Government Commission Appointed to Report upon the Improvement of the Railway Connections of Amsterdam (Verslag van de Staatscommissie tot het Instellen van een Onderzoek naar de Wijze van Verbetering der Spoorwegverbindingen om Amsterdam). R. A. van Sandick. An exhaustive review of the report of the Commission, with maps, profiles, and sections. 8000 w. 2 plates. De Ingenieur.—Feb. 3, 1906. No. 75153 D.

Southern Pacific Terminal Depot at Alameda Mole. Illustrated detailed description of the terminal arrangements recently built to replace the terminal destroyed by fire. 1200 w. Ry Age—Feb. 16, 1906. No. 75035.

The Operation of a Busy Terminal District. C. H. Ketcham. Suggestions for organization and management, with a brief description of working at the Hoboken terminal of the D., L. & W. R. R. Also discussion. 10000 w. Pro N Y R R Club—Jan. 19, 1906. No. 75089.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Car Supply.

Ways and Means to Maintain Car Supply. L. C. Bihler. Abstract of an Address before the Traffic Club of Pittsburg. Calls attention to features needing correction. and the need of practical cooperation between shippers, motive power, operating and traffic departments of railroads. 1700 w. Ry Age—Feb. 23, 1906. No. 75251.

Rates.

Argument against Two-cent Passenger Rate in Ohio. James McCrea. Address before House committee on railroads and telegraphs of the Ohio Legislature. 3000 w. Ry Age—Feb. 9, 1906. No. 74958.

Senator Lodge on Rate Regulation. Abstract from speech on rate regulation in the United States Senate, Feb. 12. 4000 w. R R Gaz—Vol. XL. No. 8. No. 75-240.

MISCELLANY.

Easement Damages.

The Park Avenue Cases. Editorial review of a legal suit and a recent decision of the Supreme Court which will cost the New York Central Railroad some millions of dollars in damages. 2000 w. R R Gaz—Vol. XL. No. 6. No. 74945.

Education.

Railway Education. Prof. E. R. Dewsnup. Suggestions for the special training of railroad education of men already in the service. 6000 w. Pro St Louis Ry Club—Jan. 12, 1906. No. 74794.

Railroad History.

Two Object Lessons in Railroad History. A comparison of progress and conditions of the railroads in the Housatonic and the Naugatuck valleys, both roads having become a part of the N. Y., N. H., & H. R. R. system. 1500 w. R R Gaz. Vol. XL. No. 7. No. 75020.

STREET AND ELECTRIC RAILWAYS

Alpine Railway.

A Gravity Cable Railroad in the Swiss Alps. Illustrated description of the remarkable railway in the Swiss Alps, connecting Lauterbrunnen with Mürren. 1000 w. Sci Am—Feb. 24, 1906. No. 75085.

The Sernfthal Railway. Illustrated description of an electric railway through an Alpine valley famous for its beautiful scenery. 1600 w. Engr., Lond—Feb. 23, 1906. No. 75378 A.

Berlin.

New Transportation Projects for Berlin (Die Neuen Berliner Verkehrsprojekte). Adolf Müller. A review of the plans now under consideration for passenger transport in Berlin; including subways, motor omnibus lines, and tramways; with maps and plans of the various projects. Serial. Part I. 3500 w. 1 plate. Glasers Annalen—Feb. 1, 1906. No. 75121 D.

Electric Railways.

Technical Considerations in Electric Railway Engineering. F. W. Carter. Read before the Inst. of Elec. Engrs. (Abstract.) Also discussion. Discusses the question of the electrification of steam railways, its problems and the systems, their advantages and disadvantages. 10000 w. Elect'n, Lond—Jan. 6, Feb. 2, 1906. Serial. 2 parts. No. 74987 each A.

The Construction of the Rochester, Syracuse and Eastern Railway. Illustrated description of the construction of a road designed for heavy traffic. 3500 w. Eng Rec—March 3, 1906. No. 75407.

Freight.

Freight-Handling by the Des Moines Interurban Railway Co. An illustrated account of an electric railway that has found hauling freight profitable. 3500 w. Ry & Engng Rev—Feb. 10, 1906. No. 74960.

History.

A Quarter Century of Electrical Railway Engineering. Franz Koester. An illustrated review of the development of electric traction since1879, showing the progress from the early experimental lines to the design of the modern heavy alternating-current locomotives. 2500 w. Engineering Magazine—March, 1906. No. 75166 B.

Illinois.

The Illinois Traction System. Illustrated description of recent improvements and extensions in Central Illinois. 5800 w. St Ry Rev—Feb. 15. No. 75229 C.

Interurban.

The Rochester, Syracuse & Eastern Railway. Illustrates and describes the construction of this electric line in New York state. The work is of special interest, as the territory traversed will be served in competition with the New York Central steam road. 3000 w. Ry & Engng Rev.—Feb. 10, 1906. No. 74961.

Lightning.

Lightning Protection. J. V. E. Titus. Read before the Ohio Int. Ry. Assn. Discusses features of lightning arresters and their methods of operation. 3500 w. St Ry Rev—Feb. 15, 1906. No. 75230 C.

Overhead Equipment.

Notes on the Construction and Maintenance of Overhead Equipment. Robert N. Tweedy and H. Dudgeon. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Discusses the variation in cost, the poles, bases, wires, insulators, &c., in the present number. 4500 w. Elect'n, Lond—Feb. 16, 1906. Serial. 1st part. No. 75276 A.

Permanent Way.

The "Romapac" System of Tramway Permanent Way. Illustrates and describes a system in which a detachable head or wearing surface is fitted to the rail, explaining its advantages. 1800 w. Engng—Feb. 9, 1906. No. 75073 A.

Rapid Transit.

The New Philadelphia Rapid Transit Subway. J. A. Stewart. Describes the completed section recently opened, and features of the construction. Ills. 1200 w. Munic Engng—March, 1906. No. 75338 C.

Rolling Stock.

Experimental Rolling Stock for the Blankenese and Ohlsdorf Suburban Railway. Gustav Dietl. Translated from *Elektrische Bahnen und Betriebe.* Illustrates and describes the cars built for these lines near Hamburg, which are operated by single-phase alternating-current of a frequency of 25 cycles per second and a mean voltage of 6,000. 4500 w. Tram & Ry Wld—Feb. 8, 1906. No. 75294 B.

Signalling.

Automatic Train Stopping. Illustrates and describes devices used on the Boston Elevated, N. Y. Subway, and other lines. 2300 w. Ry & Loc Engng—Feb., 1906. No. 74854 C.

Single Phase.

Comparison Between Single-Phase and Three-Phase Equipment for the Sarnia Tunnel. C. L. de Muralt. Compares the advantages of the two alternating-current systems, especially considering the three-phase system. 5000 w. St Ry Jour—Feb. 17, 1906. No. 75031 C.

Gas Power in the Operation of High Speed Interurban Railways. J. R. Bibbins. Briefly describes this single-phase high-voltage system of the Warren & Jamestown railway, and the exclusive use of gas power. Ills. 5800 w. Eng Rec—Feb. 17, 1906. No. 75052.

Single-Phase Alternating Current Railway Work. Lionel Calisch. Considers the various single-phase motors which can be used for traction purposes and their application to railway work. Ills. 3500 w. Sci Am Sup—Feb. 24, 1906. No. 75087.

Single-Phase Traction on the Borinage Railway. Abstract of a description published by the Allgemeine Elektricitäts-Gesellschaft. The line runs through a coal-mining district in Belgium. Ills. 1700 w. Tram & Ry Wld—Feb. 8, 1906. No. 75295 B.

The Warren and Jamestown Single-Phase Railway. Illustrated description of this electric line and its equipment. Horizontal gas engines are used as prime sources of driving power, and the single-phase alternating current system. 3500 w. R R Gaz—Vol. XL., No. 7. No. 75024.

Traction by Single-Phase Alternating Current at 15,000 Volts (Traction par Courant Alternatif Simple à 15,000 Volts). S. Herzog. Detailed description with illustrations, of single-phase electric locomotive, made by the Oerlikon Works, for the Oerlikon-Wettingen railway, near Zürich. 2500 w. 1 plate. Génie Civil—Feb. 10, 1906. No. 75129 D.

Snow.

The Snow Problem in Marquette. Hamilton Baluss. Illustrates and describes methods of combatting snow when the fall is very heavy. 1200 w. St Ry Jour—Feb. 17, 1906. No. 75032 C.

Station.

The Grand Avenue Station of the Consolidated Railway Company at New Haven, Conn. Illustrated description of a plant which is producing power at such low rates as to make a detailed study of the equipment and operation of interest. 2500 w. St Ry Jour—March 3, 1906. No. 75351 C.

Tube Railways.

The Baker Street and Waterloo Railway. An illustrated description of this first of the new tube railways of London now approaching completion. 3300 w. Elect'n, Lond—Feb. 16, 1906. Serial. 1st part. No. 75274 A.

Tunnel.

The Kingsway Shallow-Tunnel Tramway. Gives an outline of the scheme and a detailed description of the completed portion and its electrical equipment. Ills. 2000 w. Elect'n, Lond—Feb. 2, 1906. Serial. 1st part. No. 74988 A.

Waterproofing.

Waterproofing at the Subway Power House, New York. Illustrates and describes the Winslow method as applied to the basement of the 59th St. power house of the Interborough Rapid Transit Co. 700 w. Eng Rec—Feb. 17, 1906. No. 75053.

Wheels.

Some Causes of Excessive Wheel Wear. Franklin M. Nicholl. Calls attention to some causes of irregular wear. Ills. 1300 w. St Ry Jour—March 3, 1906. No. 75352 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U.S.A.
American Machinist. *w*. New York.
Am. Manufacturer. *w*. Pittsburg.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *m*. New York.
Automobile Magazine. *m*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Am. Iron and Steel Asso. *w*. Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Review. *m*. Montreal.
Cassier's Magazine. *m*. New York and London.
Cement. *b-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A,
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Nile.

The Nile in 1904. By Sir William Willcocks, K. C. M. G., F. R. G. S. Size, 10 in. by 7 in.; pp. 225. Price, 9 shillings. London: E. & F. N. Spon, Limited. New York: Spon & Chamberlain.

In view of the important engineering works which have already been constructed for the improvement and regulation of Egyptian irrigation on the Nile, and still more because of the works yet to be undertaken, this is a welcome contribution to the literature of hydrology.

Sir William Willcocks takes the occasion of the publication of the Egyptian blue book report on the basin of the upper Nile, by Sir William Garstin, as the basis of his book, and aims to bring Lombardini's "Hydrology of the Nile" down to date, a work for which his own experience in recent engineering works in India renders him eminently fitted. He divides the work into five sections or chapters, these treating successively of the river in general, of its tributaries, the present methods of its utilisation, projects for the extension of its utilisation, and a review of the vases and geology of Egypt, this last chapter being the work of Mr. H. J. L. Beadnell, F. G. S., F. R. G. S.

The first two chapters include some valuable profiles and sections of the stream and its most important tributaries, while the section on the utilisation of the river gives some important data concerning the volumes of discharge, the nature of the muddy deposit and the existing cultivation, and methods of irrigation.

So far as new projects are concerned, these form the most interesting portion of the book. Of the total irrigable area of Egypt estimated at 6¼ million acres there are two million which need artificial works for their perennial irrigation, and such works would increase their value by £30 per acre, or a total gain of £60,000,000.

To effect this irrigation will require the storage of four milliards of cubic metres of water, on the basis of one milliard to half a million acres. The Assuan dam provides for but one milliard of cubic metres, and its supply is already all devoted to special tracts, so that something more must be done.

Briefly, the recommendations of Sir William Willcocks are: to raise the height of the Assouan dam by six metres, adding another milliard of cubic metres to the capacity of the reservoir behind it. This being done, the Wady Rayan depression should be utilised as a reservoir, as was clearly pointed out by Mr. Cope Whitehouse, twenty years ago, this supplying the other two milliards of cubic metres, and forming a modern counterpart to the lake Moeris of ancient Egypt.

This recommendation has added interest at the present time because of the success which has attended the efforts of Mr. Whitehouse to prove his claims to the origination of this idea, and to sustain the correctness of the project against the opposition of its detractors.

In view of the interest which the development of these important works is likely to attract, the book of Sir William Willcocks will prove a valuable store of facts and information about the Nile not only for the engineer but also for the general reader.

Physics.

Physics. By Charles Riborg Mann and George Ransom Twiss. Size, 8 in. by 6 in.; pp. x, 453. Price, $1.25. Chicago: Scott, Foresman & Co.

The older text books on physics were modelled somewhat after the scholastic treatises on mathematics, the illustrations and examples being selected from laboratory and lecture room apparatus and methods, apparently without any intention of indicating to the students that the phenomena under consideration were occurring all about him in the course of daily life. Now comes along a pair of heretical teachers, who actually have the temerity to preface their book with a picture of the 20th Century Limited, and introduce the subject with references to the savage making his first fire, and talk about telephones, trolley cars, and other such vulgar things.

We are heartily glad that Messrs. Mann and Twiss have thus begun the good work, and still better pleased that they have conducted it without striving after a so-called popularity which is supposed to condone flippancy and inaccuracy. The book is a good one, well up to date, and filled with intelligent and interesting examples and illustrations. The phenomena of circular motion are illustrated by the action of railway trains on curves, and by the spectacle of the "loop-the-loop"; pneumatic and hydraulic laws are demonstrated in connection with modern waterworks engines, air compressors, and rock drills. Santos-Dumont replaces Montgolfier; the equipment of the modern electric power station appears to crowd out the crude dynamos of the lecture-room table. At the same time theory is not neglected, but the student is led to perceive the applications of the laws and theories of physics to his daily surroundings, and things so learned are not forgotten, and what is still better they are so intimately connected with habits of thought that loose thinking in other lines is minimized, and one of the fundamental ideas of education furthered. It is to be hoped that some of the other departments of elementary education will be supplied with similar modern text books; there is certainly room for them.

Concrete.

Concrete Construction About the Home and on the Farm. Size, 8½ in. by 5½ in.; pp. 127. New York: The Atlas Portland Cement Co.

The use of domestic Portland cement has grown in the United States from 150,000 barrels in 1885, to more than 25,000,000 barrels in 1904. Much of this is due to the employment of concrete in foundation and general construction, but a large quantity of cement is used in general building work. This little book is intended to encourage the employment of cement and concrete construction in household and farm building work, and it shows very clearly how much structural work formerly made of timber, and carpentry work may be replaced by neat and even ornamental buildings, wholly fireproof, and very durable, and built largely with the use of such labor as is available about the farm and in the country. Details of simple elements in reinforced concrete are given, with numerous illustrations of cellar, floor, barn, and outbuilding construction, enabling the ordinary builder to accomplish very satisfactory results with comparatively unskilled labor.

Valve Gears.

Link Motions, Valves, and Valve Setting. By F. H. Colvin. Size, 6 in. by 4 in.; pp. 82. Price, 50 cents. New York: The Derry-Collard Co.

This little book is intended to give a clear idea of the manner in which locomotive reversing valve gears of the type commonly known as the Stephenson link motion should be designed and adjusted.

The recently discovered evidence that this motion was invented by Williams, and not by Howe, is noted, and the writer then proceeds to explain, by the aid of simple diagrams, and in very clear language the manner in which the link motion operates. The book is undoubtedly a useful one for men to whom the more elaborate treatises of Auchincloss or Zeuner are not easy reading, and it will doubtless fill a place among books for the traveling locomotive engineer very acceptably. A brief mention is made of other gears than the ordinary link motion, and there might have been more space given to the Walschaert gear, which is undoubtedly coming into extensive use in the United States in connection with the development of the four-cylinder compound locomotive.

Bridges.

The Design and Construction of Metallic Bridges. By William H. Burr and Myron S. Falk. Size, 9 in. by 6 in.; pp. xiii, 532. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Although this book is based upon the ninth edition of Professor Burr's treatise on bridge and roof trusses, it has been so thoroughly rewritten and had so much new matter added that it is practically a new work, and as such has been given a new title.

The present volume is intended to form a comprehensive treatise covering all types of trusses used to a material extent in American practice, with the exception of suspension bridges and bridges having arched ribs, these being intended to form the subject of a later work. Analytical methods are generally employed, and in the treatment of swing bridges these are supplemented by the use of the methods of influence lines and deflections.

After a brief historical introduction, the work discusses the general types of trusses, with the nature and magnitude of loads to be carried, together with the specifications of leading railroads and bridge builders in the United States. The succeeding chapters treat of moments and shears, for plate girders; of trusses with parallel and horizontal chords, and of non-continuous trusses with chords not parallel, this chapter also including roof trusses. Swing bridges are very fully treated, and the book concludes with an analysis of wind stresses, and a study of details of construction.

Measurements.

Elektrotechnische Messkunde. Von Arthur Linker. Size, 210 mm. by 140 mm.; pp. viii, 442. Price, 10 marks. Berlin: Julius Springer.

A useful handbook both for the technical laboratory and for the practising electrical engineer in the office or in the field. After an extended chapter on the general methods of electrical measurement, there follow detailed sections on magnetic measurements, measurements with direct and with alternating current machines, and a chapter on the practical methods of photometry. The book contains some portions involving a familiarity with the principles of higher mathematics, but these are so arranged as to cause no interference with the more practical parts, while giving demonstrations of methods for those who desire to follow out such investigations.

There are many diagrams, and graphical methods are freely employed throughout, the book being an excellent example of German thoroughness and care, while the appearance of the volume is fully in keeping with the high reputation of the publisher.

Dynamos.

Dynamo-Electric Machinery. By Silvanus P. Thompson. Seventh Edition. Volume II. Alternating-Current Machinery. Size, 9 in. by 6 in.; pp. xx, 848. Price, 30 shillings. London: E. & F. N. Spon. New York: Spon & Chamberlain.

During the nine years which have elapsed since the sixth edition of Dr. Silvanus Thompson's book of alternating-current machinery appeared there has been a remarkable extension in the use of alternating currents, and many developments in the machinery itself, so that it has been found necessary to prepare what is practically an entirely new work. A new chapter on periodic functions has been written, and the method of harmonic analysis, in a novel and simplified form, applied to the discussion of the wave-form of alternating electromotive forces and currents.

In the chapter devoted to magnetic leakage and armature reactions the principle of superposition of magnetic fields is extensively employed, and a distinction is made between the permanent and the periodic portions of armature interference, this rendering it possible to simplify the method of predetermining the curve of performance of an alternator on an inductive load.

The question of windings of alternators for single-phase, two-phase, and three-phase machines is considered both for generators and for motors, with photographs showing the practical methods employed in the works of prominent manufacturers. The practical nature of the book also appears in the extent to which methods of design are considered, the formulas given being those actually employed in the shop, including constants derived from the experience of the best makers. In this portion of the book methods of design are considered for machines of various speeds, including those driven by high-speed steam turbines, as well as those connected to large reciprocating engines.

Alternating-current motors are fully discussed, a chapter being given to the single-phase induction motor, and one to the alternating-current commutator motor.

The book concludes with an appendix upon the standardisation of voltages, frequencies, and ratings, comparing the recommendations of the British Engineering Standards Committee with the American and German rules.

Electrical Power.

Principles of Electrical Power for Mechanical Engineers. By A. H. Bate. Size, 7 in. by 5 in.; pp. xii, 204. Price, 4 shillings 6 d. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain.

This convenient little work is one of the Finsbury Technical Manuals, prepared both for the use of students, and for reference by practising mechanical engineers. It deals with continuous-current work only, and that from the end of the motor alone, the current being assumed to be furnished to the establishment, so that problems of distribution and control are included, as well as the design and rating of motors, and their applications to machine driving. Such a work will doubtless find many readers to whom it will be welcome, and it may lead them to larger and broader works in the field of applied electricity.

Shop Methods.

Machine-Shop Tools and Methods. By W. S. Leonard. Size, 9 in. by 6 in.; pp. vii, 554. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This book was originally prepared for use in the course of instruction given in the shops of the Michigan Agricultural College, and it has now been extended and issued in a new edition for more general circulation and use. In this form it constitutes an excellent instruction for students, and should also be very useful for the apprentice and for the ambitious mechanic who is anxious to make more rapid progress in his knowledge of shop methods than he can obtain in the course of his daily work. There are many workmen, both student-apprentices and helpers who, by the use of such a book could obtain a familiarity with ordinary workshop processes in a far shorter time than is possible by simply following the shop routine in the position which he may hold, and it is in such a way that much trouble in connection with the apprenticeship question may be obviated. Shop methods cannot be learned from books alone, but such aids to an acquisition of modern tools and their operations may be greatly facilitated by such means.

The work is copiously illustrated, and the fact that many of the illustrations are from the trade catalogues of eminent tool builders does not detract from their value.

Space Telegraphy.

Wireless Telegraphy; Its History, Theory, and Practice. By A. Frederick Collins. Size, 9 in. by 6 in.; pp. xii, 300. Price, $3.00. New York: McGraw Publishing Company.

In the course of the decade which has passed since the appearance of telegraphy through space by means of magnetic waves it has taken its place as an important element in social and commercial economics. Many changes have been made in apparatus and methods, and hence a review of the development of the art and some indication of the lines along which progress may be expected will be acceptable. Mr. Collins, whose name is not unknown in connection with this subject, reviews the subject as a whole, discussing first the physical phenomena upon which the operation of space telegraphy depends; giving chapters upon the ether, upon wave motion, electric waves, the disruptive discharge, and electrical oscillations. From these theoretical elements he passes to the consideration of oscillators, interruptors, transmitters, detectors, and all the detailed apparatus by means of which the waves sent out by the transmitting station are received and interpreted at a distance.

A special chapter is given to the subject of syntonization, including the methods of tuning by means of which a message may be received only by the station for which it is intended; the book concluding with a chapter on wireless telephony.

Fire Protection.

L'Incendie: Ses Causes, sa Prevention, son Extinction. Par Félicien Michotte. Size, 250 mm. by 160 mm.; pp. vi, 564. Price, 16 fr. 50. Paris: Vve. Ch. Dunod.

This work, issued under the patronage of the Technical Fire Prevention Committee of France, may be considered as a semi-official publication, exhibting the latest French practice, both as regards fire prevention and fire extinction.

Treating first of the causes of fires and the effects which may be produced under various conditions, M. Michotte passes to the more technical portion of his work in discussing fire-proof construction, and the methods which may properly come under the heading of preventive methods, such as automatic fire-alarms, automatic sprinkler systems, and the like. In these, as in the other portions of the work, the author shows himself thoroughly familiar with the practice of other countries, citing the methods employed in Germany, England, and the United States with fulness and effect.

Passing to methods of fire extinction, the book discusses local appliances, such as chemical fire-extinguishers, permanent hose connections, force pumps, etc., followed by a review of the apparatus and methods of the regularly organized fire departments.

A chapter is devoted to methods of fire prevention and extinction in the country, where fully equipped departments are not available, and the work closes with a discussion of the protection of theatres, factories, and other buildings occupied by many people, against the dangers of fire alarms. The book is an excellent example of the specialized type publications more common with the Continental press than in Great Britain or the United States, and it might well serve as a model for similar works devoted more particularly to local methods.

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AMERICAN COMMERCIAL RELATIONS; A COMING INTERNATIONAL PROBLEM.

Maurice A. Oudin.

In introducing Mr. Magee's article concluding his series in our February issue, we cited the significant fact that the leaders of the industrial world in America were already sounding a warning against the policy of extravagance with natural resources and indifference to outside markets. There can be no doubt that this conception will spread rapidly in the near future, and that action based upon it will materially modify the politics and policy of the United States, and thence the international relations between the New World and the Old. Mr. Oudin carries forward the discussion of this theme from the point where Mr. Magee left it, and he also writes with authority as well as with very great interest.—THE EDITORS.

A NATION'S war footing has always been held a fair indication of its rank as a power. In recent years it has become necessary to extend this proposition so as to include the idea that the magnitude of a nation's foreign trade is also in a way a gauge of its international rating. This modification of the original assumption is a natural one when we recognize that the prosperity of a highly organized and populous community is closely related to its activity in the commercial interchange of nations. Without prosperity in a body politic, the "sinews of war" will be lacking.

If not the existence of England's empire, certainly her continuance as one of the world powers depends upon her commercial supremacy. Deprive Germany of her continental and oversea trade, and the restless activity and ambitious designs of her Emperor would become as unimportant as they are now capable of bringing forth far-reaching results. It is an economic weakness of these countries that restriction of an already established foreign trade would produce dire finan-

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cial results. The profits from the internal trade alone, in the case of England, would be barely sufficient to keep her people from starvation, and in the case of Germany would not be sufficient to maintain her military and naval establishments and her great public works. The United States, on the other hand, would today suffer little in comparison with these two countries. Its domestic commerce is roughly estimated to be equal to the aggregate exports of the rest of the world. So small a proportion of the total volume of American business is foreign trade, that the latter may undergo a severe diminution without seriously affecting the financial situation of the country. This fortunate position of the United States will not last forever; Americans will find themselves, perhaps within this generation, facing (as European nations now do) the possibilities that result from the lack of a foreign trade.

It will be seen why one of the first duties of a Government is to favor, in every possible way, the growth of commerce. In the furtherance of this policy, diplomats have become in fact commercial agents, one of their chief missions being to safeguard the industrial welfare of their respective countries. Acting upon the generally accepted axiom that "trade follows the flag," territorial aggrandizement at the expense of weaker nations has been the consistent policy of most European powers. International disputes now have their foundation in commercial rivalries. Sentiment, traditional friendship, or the prejudice of centuries, may be forgotten over night, in the face of some great strategic position taken by a rival.

Home-seekers have given place to trade-seekers as pioneers of civilization. The portions of the globe habitable by the white races, for the most part are well settled. The westward progress of the farmers of the United States, resulting from the venturesome and restless spirit that produced the miracle of the peopling of the Great West, has long since ended. The Siberian frontier was obliterated at a still earlier date by the line of settlements stretching from the Ural Mountains east to the mouth of the Amur. The hardy grazers of Australia and of temperate South America, occupy most of the desirable land. These argonauts were conquerors of the wilderness for themselves and their children. The modern pioneer is no settler, no home-seeker. He is the engineering expert and promoter, and his field is the unknown, and often uncomfortable, quarters of the globe; those stretches of mountain, plain and forest, inhabited for the most part by inferior races. He is encouraged by his Government, and the knowledge of immunity of his plans from local dangers, has given him more heart and added to his audacity.

The far-reaching arm of a Government which encourages and fosters the commercial enterprise of its citizens, is represented by its consular system. This system had its beginning in the necessities arising out of the Oriental trade of the Italian cities. At first, a representative merchant was selected to decide disputes between members of the foreign colonies. The advantage of this practice became apparent to Governments, who assumed the right to make these selections. These officers became known as consuls, and were appointed to act in one another's dominions. With the growing importance of foreign trade, the legal jurisdiction was restricted, and today the most important duties of consuls are those which directly bear upon the advancement of the commercial welfare of their respective countries. Accordingly, a not unimportant duty of a consul is to report on the state and progress of manufactures, the requirements of the inhabitants of the country to which he is sent, the condition and extent of trade with other countries, and to make recommendations for diverting to his own country business going in other directions. The efficiency of a consular system as a whole is determined by the intelligence displayed in the reports of its consuls, and in the wisdom and practicability of their recommendations.

While today a diplomat's mission in its ultimate results is of a commercial character, it must not be overlooked that in the past he has been responsible for great treaties which have been totally without a political complexion. A commercial treaty with France was negotiated by Franklin in the second year of independence of the youthful American nation. A treaty with Holland, which followed a few years later, was of the same kind and was made possible by the cupidity of the merchants of Amsterdam, who hoped thereby to obtain a great share of American trade. The furtherance of commerce under the Confederation was impossible, as Congress had no power over commercial matters. The present Constitution was in part due to an appreciation of this lack of power. Commercial treaties have been negotiated by the United States with all the civilized countries. Early in its history as a nation, it inaugurated the policy of securing for its citizens the commercial benefits of the free navigation of rivers and seas. As a matter of international law, the United States first insisted that people who live along the upper waters of a river have a natural right to sail to the sea through the territory of other powers. We have made free to all, the navigation of the St. Lawrence, the River Platte, and the Amazon rivers in America. The principles of free navigation have also been applied to the Scheldt, the Rhine, and the Danube in Europe, and the Congo and the Nile in Africa. By very reason of the policy not to engage in foreign alliances, America's formally contracted obligations with other powers have been for the most part commercial rather than political.

Such was the excuse, if any is needed, for the presence of the United States at the International Conference about Morocco. As one of the signatories of a convention with Morocco, held at Madrid over twenty-five years ago, it was bidden to attend the conference at Algeciras. The invitation was accepted as a right and as a duty, because one of the articles of that convention confirmed to all the Powers represented, the treatment accorded to the most favored nation. The protection of these commercial privileges, and not the political questions involved, was the object of American participation in the conference. The instructions of the Secretary of State to the delegates covered four points. The policing of the border country was to interest the United States solely in so far as it tended to ensure the open door for the commerce of all nations. The reform of the finances was to have absolutely no other interest than that the measures to be adopted should be such as not to interfere with equal rights for America to trade with Moroco. Private monopolies would be of interest, in that they tended to destroy the enjoyment of equal rights and their prevention was to be insisted upon, as was the suppression of smuggling because of its effect on the open door and on the prevention of orderly commercial relations.

A large part of the machinery of Governments, it will be noted, is working in the direction of making more effective the efforts of its citizens to market their productions abroad. The American Government has not been the least active in this respect. An inquiry into the results will, I think, lead us to the conclusion that the commercial advantages secured by their at times brilliant diplomacy, have not been fully utilized by American merchants and manufacturers.

The foreign trade of the United States is regarded by a large number of people with a certain mixture of indifference and pride—indifference, because of absorption in the vastly greater interests of the home markets, and pride that by the records only England has a larger foreign business. This indifference may also be ascribed to a certain provincial attitude of mind towards present conditions and a disregard of future necessities. Our pride as Americans is largely based on a general impression of our greatness as international traders that is hardly justified by the actual conditions.

The total foreign trade of the United States has more than doubled in twenty-five years. Month by month, the record of imports and exports is broken, and the crest of the wave does not seem to have been reached. While recognizing the right to indulge in a vast deal of satisfaction with such an achievement, let us consider what right we of the United States have to be as elated as we are encouraged to be by an array of figures. Our European competitors are more interested in what and how much we sell, than in how much we buy from them and oversea countries. Our rivals use every means to combat our export trade, while considering it good business to encourage an increase in the other account. They are also as much interested in the kind, as well as in the amount, of American sales abroad; for the former, in a way, is a measure of America's position in the world's exchange. In fact, a country is largely respected and feared by its commercial rivals according to the extent of its international sales of manufactured goods.

During the past fiscal year, the exports from the United States were over one and one-half billions of dollars. Approximately two-thirds of this amount stands for the output of the soil, waters, mines, and forests—natural products. There is left the second great classification—manufactures—representing the most advanced of all articles which are the subject of barter and exchange. In their production, a man's physical effort finds its highest reward. An average workman, aided by automatic machinery, in one year will add one thousand dollars to the value of the raw material passing through his hands. A farm-hand ordinarily will not increase the wealth of the nation by one-quarter of this amount. The production of manufactures further requires the exercise of a man's highest faculties, and to dispose of them to his neighbor, demands in addition that they shall be better or cheaper than another's skill, brains, and ingenuity can make them. In the one-half billion dollars and more of these articles exported from the United States are included copper electrolytically purified and rolled, and refined mineral oils—"manufactured articles" by courtesy only. These two items comprise about thirty per cent of American manufactured exports. Thus analyzing the exports and reducing them to this basis, we find the United States on a lower level than England, Germany or France. England is so hopelessly ahead of us that we must leave her completely out of the category of rivals to be jealous of. Little Switzerland sets us a good example by her relatively large foreign sales. For every man, woman and child, she sends away in manufactured goods the value of six dollars per annum. This is ten times as much for each inhabitant as the corresponding export trade of the United States. If America were as active, her exports of this kind would be nearly four billion dollars, or as much as the foreign business in manufactures of the entire world.

It is not intended here to lessen in the remotest degree the importance and value of business in raw products. This trade brings to us in exchange the wealth of other nations in the form of money or commodities. These resources are not without end, however, at least they are not for always available for the export trade. Our American forests are disappearing. The output of our mines is being absorbed by ourselves in an increasing amount, year by year. Today our wheat supply is sufficiently large—even bountifully so—to feed our people. In another generation, when the population of the United States will be twice what it is today, the great outflow may cease and an opposite current may set in, through the inability of the country to supply its own needs. This part of our trade cannot be considered permanent. It is upon our exports of manufactures, then, that ultimately we, in common with other nations, must depend for our real position in the the Parliament of Powers. When we reach a point in our development where we absorb our own natural productions, we will be forced in order to maintain our prestige, to become what we are not now—adepts in the foreign trade.

For the present, America's exports of natural products pay for the purchase of the manufactures of other nations to the extent of nearly one billion dollars, and she enjoys the respect to which magnificent extravagance is entitled. An unusual prosperity, a high standard of living, and a seemingly insatiable desire for luxuries, as well as a present condition of need, have created the enormous demand. Herein lies a certain immunity from foreign wars. Our rivals are too greedy for our trade to jeopardize it by wanton attacks. By reason of its basis, our foreign purchase account is sensitive, and our custom precarious. In hard times, we buy as little as we can. Unlike England, who is dependent upon the outside world for her supply of food and for raw and for partly manufactured materials to keep her mills and factories running, we raise all we need to eat, and could, if we were hard put to it, make almost all the things we import.

An American Consul, replying to the question as to what was the greatest need of the American manufacturer, said that it was to convince himself that he actually wanted to seek foreign business. This idea has been put rather more strongly by the financial correspondent of the London Times, who has this to say:

> "The truth is that foreign trade in any way is now beyond the knowledge of American people. I was almost tempted to say that it is beyond their desire and intentions. That in an indefinite way they would like to have a foreign trade is perhaps true, but for the reason that they have been so long accustomed to look to the home market, it is impossible for them to take the steps that would give them any considerable show in foreign markets. After all, Americans are the most conservative people in the

> world so far as outside conditions are concerned, and so where these are involved they are content to go on doing a foreign trade that is merely complementary to the home trade."

This general attitude of indifference to the extension of commerce, and the conservatism of American bankers and merchants toward outside affairs, is strikingly shown by the failure to comply with certain requisites for the development of this trade, which involve no great risk or inconvenience. These are the establishment of foreign banks and of steamship lines of American ownership, and the granting of more or less extended credits. Among other handicaps to the increase of American business abroad, may be mentioned actual ignorance of geography and of postal rates, bad packing, disregard of shipping instructions, of customs regulations, and indifference to the tastes and peculiar requirements of a people whose trade is sought.

The methods of American manufacturers engaged in the foreign trade have been described as very crude in comparison with those employed by their European competitors. Indeed, we have not emerged from the kindergarten class. It is exasperating to our customers to have to pay short postage on letters from America. The superficial knowledge of our office and mailing boys, and a reflection on their superiors, is shown in the constant misdirection of letters. The disregard of customers' instructions and of customers' regulations is a special complaint against American shippers. The regulations of Spanish-American countries are specific and rigid, and failure to comply with them in every respect involves a fine. A severe and perfectly just criticism is made of our careless and improper method of packing. We should copy the Europeans in this matter. There is no scarcity of wood and nails in the United States, but of knowledge and of interest as to the quantity necessary to insure the safe arrival of the goods at their destination. A case that is only strong enough for carriage by box car is no protection for goods shipped half round the world, handled many times, and perhaps buried beneath tons of cargo.

We should also follow the lead of our chief competitors in catering to the tastes and wishes of foreign customers, and in studying their national traits. Every nation has prejudices and peculiar requirements that to unthinking people may be considered absurd. The Chinese have shown a fondness for talking machines. A certain make of phonograph was offered for sale, having as a trademark a picture of the machine and a listening dog. The trademark or "chop" was considered undignified and of doubtful propriety, because of the connection—obvious in the Chinaman's mind—of a dog with a human audience. The substitution of an aged Chinaman for the dog removed the ban of unpopularity.

The value of cheap and direct transportation to foreign markets in building up outside trade has been disregarded by the United States Government. That it does not employ the methods of European Governments, who regard the protection and extension of their commerce as of first importance, is mainly due to party politics, assisted by the prejudices of the inland representatives. The necessity of aiding the merchant marine is so obvious as hardly to admit of argument. The great trade of England and of Germany owes a large measure of its success to Government subsidies in one form or another. This assistance has made possible the establishment of the many steamship lines intersecting the oceans highways, and uniting every important port of the commercial world with their own maritime centers.

At the beginning of the Civil War, American ships carried 65 per cent of the foreign commerce of the country. Forty-five years later they were carrying less than 8 per cent of it. To such a low ebb have we come that during 1903, not an American ship entered or cleared from a single port in Austria, Denmark, Germany, Greece, Italy, Netherlands, Norway, Russia, Sweden or Turkey. In June, 1904, not a vessel flying the American flag passed through the Suez Canal.

During seven years, the United States Army and Navy cost about one billion dollars. A small percentage of this sum devoted to the upbuilding of the merchant marine would enable American citizens in due time to retain in the country a large part of the two-hundred million dollars annually paid foreign ship-owners.

The importance of cheap and direct transportation to any market diligently sought is shown by the extraordinary increase of American business with Turkey after the establishment of monthly sailings direct from New York. American products prior to 1899 were carried 6,000 or 7,000 miles in a roundabout route. England, Germany, Austria, and Italy controlled the carrying trade and pre-empted the Turkish market. Competition with the American ships reduced freight rates one-half. The result was that exports from the United States to Turkey in 1897 must be multiplied thirteen fold to arrive at our exports in 1902. That the growth was due to direct service is shown by the absence of any gain at ports not touched by the direct service.

Among other handicaps to the extension of trade are a high protective tariff and the influences of trade unions. The high tariff on imports certainly operates against building up a large and lasting market for export products. It makes high prices at home, and because of the increased cost of production, it keeps them high abroad and prevents successful competition. The aim of all labor organizations is to multiply the number of workmen by reducing the number of working hours. This tends to increase the cost of labor. Countries not so dominated by the labor element have the advantage in the struggle for an outlet for their productions. The United States can not indefinitely indulge in both these policies in their present extreme tendencies, and hope for ultimate success in capturing foreign trade. Whether the good to be gained would justify a change in economic policy, or a more decisive stand against the unreasonable encroachments of organized labor, is open to discussion. We should, for the sake of a better understanding of the future possibilities of foreign trade, have always clearly before us the incontrovertible fact that both these conditions are absolutely incompatible with supremacy in our commercial relations.

Despite the handicaps referred to, American activity abroad is increasing. As a result, the cry of the American Peril has been made familiar by frequent reiteration in Continental news items. This invasion of European markets has stirred up a number of Chancelleries, it is said, to the point of proposing concerted action against the danger. Many believe America has earned this resentment. But, what are the facts? Let us consider the case of Germany. Last year she sold us over one hundred and fifteen million dollars worth of her manufacturers, and in return took not quite fifteen million. It does not affect the argument that we sold her in addition, over two hundred million of our natural products, chiefly cotton, raw materials, and provisions—products which she is obliged to buy of us for the most part, and which we would sell to other countries if she did not take them. It is due to the appreciation of this situation by German manufacturers, that in spite of the agrarian opposition, that country having much to lose and little to gain, has receded from her threat of a tariff war. She has postponed for one year, as far as the United States is concerned, the operation of her new system of tariff relations.

The fact that sewing-machines, typewriters and machine tools could successfully compete with the home-made articles, in spite of a heavy tariff, has aroused Germany to a consideration of the future possibilities of American export trade. The German manufacturer, keen, critical, far-sighted, and adaptive, well knows that today American attempts at securing foreign trade are, in general, haphazard and unscientific. Most German manufacturers export from 50 to 75 per cent, or even more, of their total product. In one district, devoted to porcelain making, 80 per cent of the output is exported. The foreign business of Germany is vital to her existence, and, therefore, is the solicitous object and constant concern of the entire nation. Her manufacturers are alarmed at what may happen. It was to be expected that they would come over to examine and investigate the United States. They have been admitted to American offices and workshops, where they have made a study of industrial conditions for the purpose of ascertaining the strong and the weak points. They have strengthened their position in the struggle for foreign trade—a struggle in which we are one of the principals. The question arises —are we wise and can we afford to disclose to our rivals, to the extent we have in the past, our processes, our industrial and factory management, and our trade secrets?

Confronted by an intelligence not less keen than ours, handicapped by labor costing us from 75 per cent to 100 per cent more, competing with a spirit of enterprise no less audacious, and distanced by an organization marvellously effective for the development of foreign trade, how are we going to come out in the forthcoming struggle for place in the world's trade? Without now considering the question of supremacy, I would say that our salvation from defeat lies in that inborn and native quality of mind, ingenuity and inventive skill. The German manufacturer is not far behind us in originality and in addition is a good copyist. In an incredibly short time after the appearance of an article that has a wide popularity, he will offer for sale a clever imitation of it. To offset his lower price, the American manufacturer must lower the cost of manufacturing, or improve the article. That improvement, the German again will copy. We are an appreciable time ahead of him in some lines of production, thanks to the ceaseless exercise of those qualities before mentioned. For example, our originality and initiative find expression in the graceful design of our shoes, the mechanical superiority of our machine tools, sewing-machines, and a score of devices, and not least in the application of ways and means to the cheap making of these and all other articles.

By so much as we make confidants of our rivals, we tend to eliminate the time element which is in our favor, thereby narrowing the distance between us and defeat.

We have much to learn from the Old World manufacturers, but not, I think, so much as we can teach them of the art of manufacturing, pure and simple. To get to know our competitors and to appreciate their good qualities, is to relieve competition of some of its harsher aspects. Their unsurpassed methods of extending foreign business and their older sciences can be acquired, and the good points of their supremely excellent systems of education, civil government and management of public utilities, can be adapted to our conditions, without parting with one of our greatest commercial assets.

During the past few years, a swarm of European engineers, scientists, merchants, and manufacturers have inspected minutely and intelligently our industrial and commercial establishments. The Germans have come in larger numbers than any other nation. They have returned filled with enthusiasm at our hospitality and liberality. Their note-books likewise have been filled, and our tools, our designs and manufacturing processes have been adopted with celerity and discrimination worthy of the Japanese. Our commercial methods and our corporation management do not seem to have appealed to them. Our lukewarm efforts at seeking foreign business have removed their fear of the bogey of the "American Peril." The reports of these gentlemen afford an excellent opportunity of seeing ourselves as others see us. The impression of American industrial conditions obtained by these trained observers, has been summarized by our Consul General Mason, formerly of Berlin, now filling the same post at Paris. The reports of these visitors to their local associations, as far as published, almost universally admit the great resources of our country, the mechanical skill of our people, the superiority of our rail transportation, and the progressive spirit always seeking a better machine or a better method than the one in use.

These critics have noticed in us a general feeling of complacent satisfaction with everything American, a conviction that what is done or produced is the best. They have noticed an ignorance and an indifference about everything outside of the United States. They have laid emphasis on the meagreness of technical information, and the trifling annual contingent of chemists, engineers, educated dyers, weavers, and electricians, as compared with the throng of lawyers, physicians, dentists, and unspecialized graduates. Continuing, to use Mr. Mason's words:—

> "But most surprising of all appeared to the German visitors the absence of any adequate system of special education for commerce, banking, and foreign trade. Reduced to simplest terms, these investigators generally conclude that the reliance on a general and more or less superficial education, together with natural adaptibility, to fit young men for almost every walk in life, and of specialized study in physical science, modern languages, and the industrial arts, will, if persisted in, neutralize much of the advantage which our country enjoys through natural resources and advantageous geographical position for the South American, Mexican and Asiatic trade."

While we may not agree with all these observations, those who have considered the matter will be inclined to admit that the surface conditions affecting the export situation are as described by these gentlemen, and that if no important factors have been overlooked, the forecast of the immediate future in that field is tolerably accurate. If these critics have made any mistake, it has been in overestimating the disadvantage of the lack of specialized training and of attention to details not always essential, though desirable, and in underestimating the value of certain national characteristics. They have missed the point that systems of education are valuable chiefly to the extent to which they create independence of thought and a high average of intelligence. They have not attached sufficient importance to inventive and mechanical skill. Thay are not aware that by reason of American freedom from Old World setting and inflexible social conditions, a national characteristic is the fresh mental grasp of great problems, resulting eventually in doing a thing in the best possible way, time and circumstances considered. Finally, there is our adaptability to new conditions, which has its special manifestation in the readiness to make sacrifices for a principle.

When the day arrives on when America feels the imperative necessity for an outlet for manufactures, it will find us ready to confess our ignorance and unpreparedness and by every means within our power to undertake the herculean task of overtaking our successful rivals, even to the extent of sacrificing a cherished domestic policy, or of asserting our legislative independence of demagoguery and other unworthy influences. By that time what will be our commercial and political relations with our European competitors? The question as to what these relations will be when the United States seriously encroaches upon the foreign trade of the world cannot be ignored. The effect on our Continental rivals of our present small successes, does not argue well for our future relations with those countries. As closer acquaintance engenders friendly relations and tends to remove misunderstanding, rancor, and mutual dread, let us do our part by encouraging the study of one another's social and economic conditions.

The answer to the question offered for consideration must be left to the future, when the bloodless but formidable struggle begins for place in the share in the world's commerce—to that time when America asserts her claim to the position to which she is entitled; because standing for what she does before the world, she cannot then remain stationary.

THE PROPOSAL TO FORCE THE USE OF THE METRIC SYSTEM.

By H. H. Suplee.

The manufacturers of the United States are just beginning to realize that there is now in Congress a concerted attempt, originating it is believed in the Bureau of Standards, and vigorously seconded by the Chairman of the House Committee on Coinage, Weights, and Measures, to secure the enactment of legislation leading to the compulsory adoption ot the metric system of weights and measures in all departments of the Government, and thence into the entire country.

It is believed that such meddling paternalism needs only to be widely known to be effectively checked, and hence it is here brought to the attention of those most nearly concerned, in order to arouse them to that vigilance which is the price of liberty.—THE EDITORS.

FOR more than ten years there has been an active propaganda going on to secure the enactment, both in the United States and in Great Britain, of such legislation as shall aid in the introduction of the metric system of weights and measures into English-speaking countries. Bills have been introduced into Congress and into Parliament looking to this end, and although no laws have been enacted over those which, many years ago, legalized the system, the advocates of compulsory legislation have persevered, with a determination worthy of a better cause, and will doubtless continue to persevere until convinced of the hopelessness of the attempt.

At the present time there is, in the House Committee on Coinage, Weights, and Measures of the United States Congress, the following bill, entitled:—"A Bill to Fix the Standard of Weights and Measures by the Adoption of the Metric System of Weights and Measures.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first of July, nineteen hundred and eight, all of the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

The chairman of the committee has been most desirous of making it appear that this bill is altogether harmless, and that it means nothing to the manufacturer, engineer, or machinist, since it applies apparently only to the departments of the Government, and to those who have business dealings with these departments. The sponsor of the bill, however, Hon. Lucius N. Littauer, known very widely as a manufacturer of gloves, has made the following statement in his testimony regarding the bill: "It is meant to be, and I hope that it will be, the entering wedge towards the adoption of the system generally."

The chairman of the committee, with a disrespect towards the United States Government, which, it is hoped does not extend to his constituents, referred to the Government as a dog, and stated, before the American Society of Mechanical Engineers, that the bill was intended to be for the purpose of "trying it on the dog," in the hope that if the Government departments could stand it, the Congress might be encouraged to further compulsory legislation and try it on the public. He refrained from mentioning the particular animal which he would select in designating the aforesaid public—probably an animal with long ears and a patient disposition, as it well might be if it submitted to such experiments.

It is time for plain speaking about this persistent attempt of certain politicians, themselves utterly ignorant of the conditions of American manufacturing industries, to enact compulsory legislation which has not been demanded by any one who has anything to lose.

Briefly, the argument for the metric system may be reduced to three counts—the greater simplicity of the tables of weights and measures; the precise inter-relation of the units of length, dry and liquid measure, and weight: and the convenience of the decimal system of notation.

The last is already practically secured in the English-speaking countries, by the general use in all engineering work of the decimal divisions of the inch or the foot: these units of themselves are even more convenient than the metre or the centimetre. The second supposed advantage exists only in the case of one medium—distilled water at 4 degrees centigrade—a substance with which no one, except possibly the laboratory experimenter, ever has to do. The third may be admitted, though with the qualification that much of the intricacy and multiplicity of the old English system of weights and measures has already disappeared, and a further wholly practical simplification might be made without uprooting the standards upon which our gigantic industries have been built.

It must be remembered that when France and Germany adopted the metric system this vast growth of machinery and tool-building industries, of structural-material manufactures, and of metal trades generally, had not come into being. Standardization was as yet an unknown idea. There was practically nothing to undo, except some simple habits of barter and trade, before the new standards were taken into use.

The situation in the United States and Great Britain today is absolutely different. Industries such as the world has never before seen have been built up, and have sent their products all over the world. And every steel section rolled, every plate turned out, and every wire drawn, every engine and dynamo and machine tool, every pipe and shaft and bolt and nut, is based upon the inch and the foot—units wholly incommensurable with the metric ones. The screw-threads of England and America are standard all over the world—and they are wholly inconvertible into any metric expression which could be used as a guide or practically reproduced by a workman. If all these measurements must be changed into metric equivalents, the *things* themselves must be changed; to believe that we could go on making them as they are now, and gauging them by the new system of measurement, is to cherish a mischievous delusion. It is not conceivable, for example, that any shop should continue, as a regular daily routine, to turn or bore work accurately to such a dimension as "25.40001 millimetres," (the metric equivalent of one inch), or to cut bolt threads on a pitch of "8.466 threads to 25,40001 millimetres" (the metric equivalent of the Whitworth standard for one-inch bolts); it is not conceivable that such standards could continue in use in specifications. We should inevitably be forced to change to integral measurements—25 millimetres, perhaps, and 8 or 8½ threads. And a similar condition would arise throughout almost the entire range of mechanical construction. Every part now standardized to decimals of an inch would have to be redesigned to commensurable decimals of a centimetre. Then the new and old would not interchange. All the old machines and all the old repair parts would become bastard. The years of earnest and costly effort, and the millions of dollars spent to secure interchangeability and standardization, would be wrecked and marked for the scrap heap by the first compulsory legislation enforcing the use of the metric system upon our manufacturers. And it would take more than fifty years of endless confusion and double-standard working to clear the deplorable and expensive wreckage out of our shops.

Let us leave generalities for a moment and listen to the men who are vitally interested and who have appeared before the committee to try to make its members listen to reason.

When the late Mr. William Sellers, the dean of the machine-tool industry in the United States, and one of the most eminent engineers on either side of the Atlantic, appeared before this committee, one of its members actually had the courage of his ignorance, and asked Mr. Sellers what was the character of his business, and what kind of tools he made! And when Mr. Sellers tried to explain to this eminent body of legislators what everybody else in the country competent to judge knew already, he was practically snubbed by another member of this intelligent assemblage and called upon to explain that he was really competent to say something upon the question. Finally Mr. Sellers was permitted to say what American manufacturers fully endorse: "The proposition to change our system for the sole object of conformity with a system which has not even been accepted in metric countries, is absurd, and could only emanate from men utterly ignorant of the conditions required, and of the necessary apparatus to fulfil them."

Another American manufacturer, one who has held the position of president of the American Society of Mechanical Engineers, Mr. Henry R. Towne, well-known both in the United States and in Europe as an eminent engineer and scientist, touched upon another side of the subject. It has been claimed that the adoption of the metric system by the United States would add greatly to its opportunities in connection with export trade to metric-using countries. Says Mr. Towne: " In the judgment of the great majority of those who are concerned in the export trade in manufactured products, the abandonment of our present standard for the French standard of length would not only be of no benefit to us, but would impose a serious handicap upon us." Mr. Towne emphasized the most important feature of the subject when he stated that to make the change from the present system would cost the manufacturers of the United States from $500,000,000 to $1,000,000,000 to replace their gauges and standards alone. It is most significant that the bill is opposed by every manufacturer who has capital invested in tools and manufacturing appliances, and that its only advocates are those who have not a dollar at stake, and who care nothing for the investments of the men whose industry makes their positions possible. Broadly, the position was most clearly stated by Mr. Towne, when he said that other nations had adopted the metric system in the hope of attaining a uniformity which the English-speaking nations have already, and which they should never be compelled to cast away, either in their Government departments or in general by any form of legislation.

Another man whose opinions will be conceded as having some weight in connection with the liberty of American engineers as to the system of weights and measures to be used with them in dealings with their own Government and with each other is Mr. William Lodge, one of the leading machine-tool builders of America. Referring to the American system of making standard gauges, templates, jigs, and similar tools, and locking up immense amounts of money in such appliances in them in order to permit the manufacture of standard appliances in tools, Mr. Lodge said: "The mere fact of the American manufacturer giving his attention to the standardizing of his products, and making it possible for him to ship them anywhere in the world and send duplicates of parts, should in itself be a sufficient argument to those handling the question not to upset all this and put such men as us out of business."

Another witness to whose testimony respect should certainly be given is Mr. Walter M. McFarland, acting vice-president of the Westinghouse Electrical and Manufacturing Company, who testified before the committee that it would cost his company $500,000 to make the necessary changes in their gauges, jigs, templates, and drawings.

It has often been said that the electrical engineers and manufacturers are in favor of the change, and there is no doubt that, so far as computations are concerned, many of the electrical engineers favor the metric system. This is the more easy on their part because it would be their employers and not themselves who would have to foot the bills. As a matter of fact, all the electrical machinery in the United States and Great Britain is built upon the existing system of measures, all dimensions being based upon the inch, and no metric dimensions entering into the completed machinery.

Many arguments have been made upon the subject of the textile industries, and it is most interesting to note that the presence on the committee of an expert in the textile manufacture has done much to confound the ignorance of some of the so-called textile experts who have been called in favor of the bill. As a matter of fact it has been shown, by overwhelming testimony, that so far as the internal organization of textile fabrics is concerned, the inch is the standard in Germany and France as it is in England and in the United States, this being undoubtedly due to the fact that the early predominance of Great Britain in the textile industries caused the British system to become so thoroughly rooted in all textile districts that it has not been found practicable to uproot it.

It must be clearly understood that we have no direct quarrel with the metric system as such. It has its merits and its defects, as every system must have. The real quarrel of the American and British engineer and manufacturer is with those who would, by means of any legislation, direct or implied, deprive him of the liberty of using whichever system he finds best adapted to his needs. Many men may find a decimal system more convenient for computation, using either the metric system or the British system decimally subdivided. Others prefer the method of continual bisection, this having been found pre-eminently convenient in the workshop and for details on construction generally. Since 1866 the citizens of the United States, whether holding Government positions or engaged in civil industries, have had the privilege of using either system legally and freely. In no case have the friends of the inch attempted to impose their views upon the advocates of the metre. Live and let live has been their rule of conduct, a rule which appears to have chafed severely upon those who prefer to count on their fingers rather than with their minds. If the advocates of the existing standards should endeavor to influence legislation to prevent their neighbors from using their beloved millimetres and kilogrammes, a fearful howl would arise; but no such impertinent interference is to be dreamed of. Let the advocates of the metre be fair-minded enough to give up their scheme of stacking the cards; let there be a square deal, and may the best system win.

But let the gentlemen at Washington have a care. The American citizen is patient, but the proverb about the anger of a patient man should not be altogether forgotten. If this pernicious and meddlesome paternalism is not dropped, and if the disposition to enact some sort of compulsory metric legislation is not abandoned, there is but one thing to be expected. The engineers and manufacturers of the United States and of Great Britain are not to be trifled with. The campaign will be carried into the technical press, into committee, on the floors of both houses of legislation, and especially among the constituents of the men who are short-sighted enough to persist, and the question will not be settled until it is settled right.

By courtesy of Mr. Wm. Dinwiddie.

THE INNER HARBOR OF ILOILO, ISLAND OF PANAY.

TRANSPORTATION IN THE PHILIPPINES.

By Lawrence E. Bennett.

Mr. Bennett is an engineer of high standing and long experience in the Orient, whose services were some time ago requisitioned by Governor Taft for the outlining of the plans of the Insular Government in providing transportation systems in the Philippines. The measures proposed have recently received a strong impetus through the assumption, by the White Syndicate, of New York, of the responsibility for building and operating three main lines in the Visayan Group. Their estimate, amounting to $11,500,000, was based largely upon the results of Mr. Bennett's reconnaissance and report, and he will remain with the enterprise as construction superintendent and assist in getting the new project under way during the coming summer. The thanks of the Magazine are expressed to Wm. Dinwiddie, Esq., late provincial governor of Lepanto-Bontoc, for many of the illustrations accompanying Mr. Bennett's article.—THE EDITORS.

THE Twentieth Century, at its very beginning, has afforded strong indications of what it will ultimately show in the way of change in the commercial relations of the world. It has been ushered in by a great and sanguinary conflict, as one result of which the Far East has become at once the cynosure of universal attention. Much of this attention has been of an evanescent nature, but there is a deeper and more lasting significance attached. While the interest has been generally a manifestation of the modern craving for sensation, careful observers of economic conditions and progress have watched rather for the reason that the *casus belli* involved the destiny of the Middle Kingdom, and the whole future of trade in the Orient. The yellow man and the white were combating for the establishment of commercial and territorial precedence in one of the most alluring of the unexploited regions of the world.

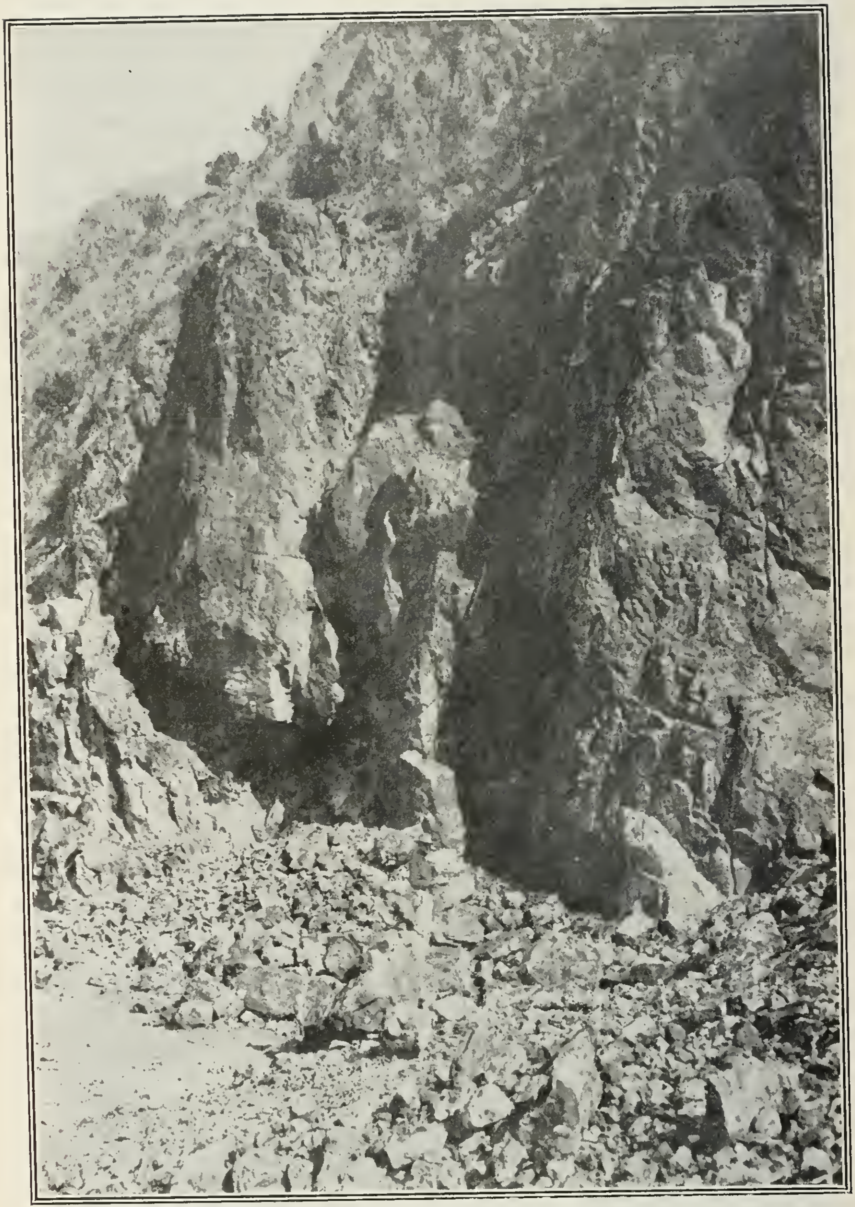
LOOKING UP THE PASIG RIVER FROM THE OLD WALL OF MANILA, BELOW THE BRIDGE OF SPAIN.

The immediate result of the Russo-Japanese war has been settled now for nearly a year, but the attention of the thinking West is apparently held as firmly as ever in the East, awaiting answer to the question of what use Japan will make of her new-found prestige. The resurrection of her great, sleeping neighbor, now comparatively imminent, is fraught with the profoundest interest for the Japanese nation. The opportunities of further progress for Japan lie in China chiefly, and this brings her face to face with the real and assumed rights and the scheme of the great western powers, important among whom now, as the result of territorial expansion and commercial interest, must be numbered the United States.

It would seem that territorial aggression in China by the western powers has been removed from the field of probability, and there has been substituted the saner economic question of the maintenance of trade rights. Because of the tremendous resources of the Chinese Empire, the beginning of the development of which but awaits the turning of a card; because of the peculiar stimulus being applied to keep alive the boycott against American goods; and because she is irrevocably bound up in the destiny of the East through possession of the Philippines, the United States must bend her energies upon the firm establishment of an oriental prestige, political and commercial. The time is the present. The future will show this to have been the inception of the psychological period, as it were, in the regeneration of China. Vacillation between such extremes as are indicated, upon the one hand, by the restitution of a justly exacted indemnity, and, on the other hand, by arrogant threats of military invasion, cannot avail the United States in China; for, with all his national weakness, the Chinaman is among the quickest to take advantage of uncertainty in another. Amicable understanding is dependent upon a just and decent administration of the Exclusion Laws, and upon a healthy trade relation.

Among the ways and means of attaining a mutually beneficent trade connection is the development, without delay, of the resources of the Philippine Islands. Thus far, Washington has been intent almost solely upon the solution of the problem of a satisfactory government for the Filipinos, and it is a problem deserving of the best thought that can be brought to bear. But the matter of making the Philippine Islands the paying investment that they ought to be, should not further suffer the neglect to which it has been subject. There is no logical reason why the two problems may not be treated in parallel. There is no conflict. To foreigners experienced in colonial administration, I have found that it is a matter of manifest surprise, not unmixed with derision, that the United States has so far allowed the Philippines to remain a drain on the national exchequer, without concerted effort to develop their resources.

A TRUCK FARM IN THE PHILIPPINES.



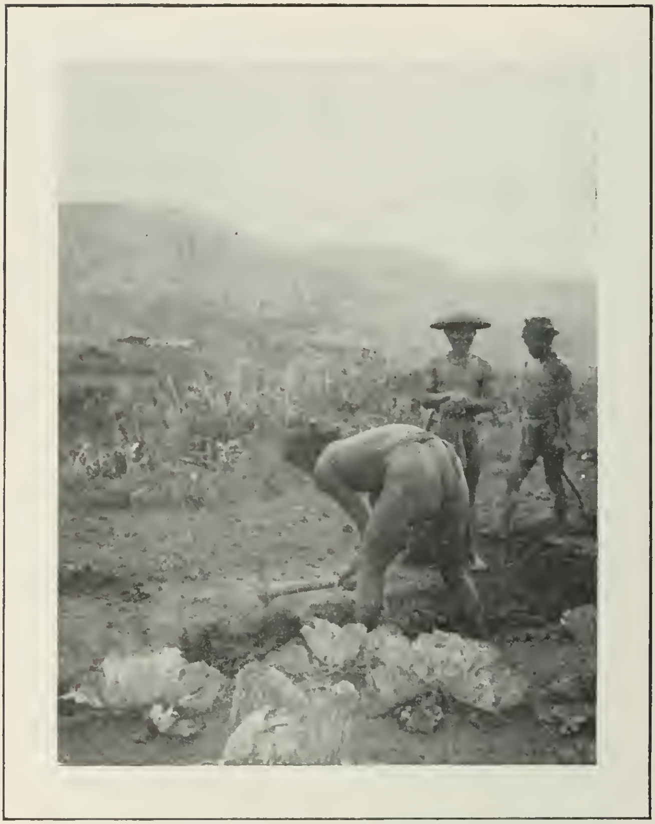
By courtesy of Mr. Wm. Dinwiddie

THE MANCAYAN COPPER MINE, LEPANTO-BONTOC.

Showing a massive exposure of ore.

Congress has shown a peculiar apathy towards the necessity of encouraging the Filipinos in the cultivation of their own natural resources—notably sugar. At the present time China furnishes a market for all of the sugar grown in the islands, and, in view of her impending regeneration, may be expected in the future to provide a demand for Philippine sugar beyond the utmost capacity of the Philippines to supply. So, while the production of the islands is susceptible of a marvellous expansion, it is not likely that American sugar producers will ever be compelled to meet the competition of the colonial product in their present markets. For years, even the carrying trade between the islands and China has been practically monopolized by Chinese merchants, who eagerly buy up the produce of the Philippine plantations for shipment, right in domestic markets. This is particularly true of the Visayan Islands.

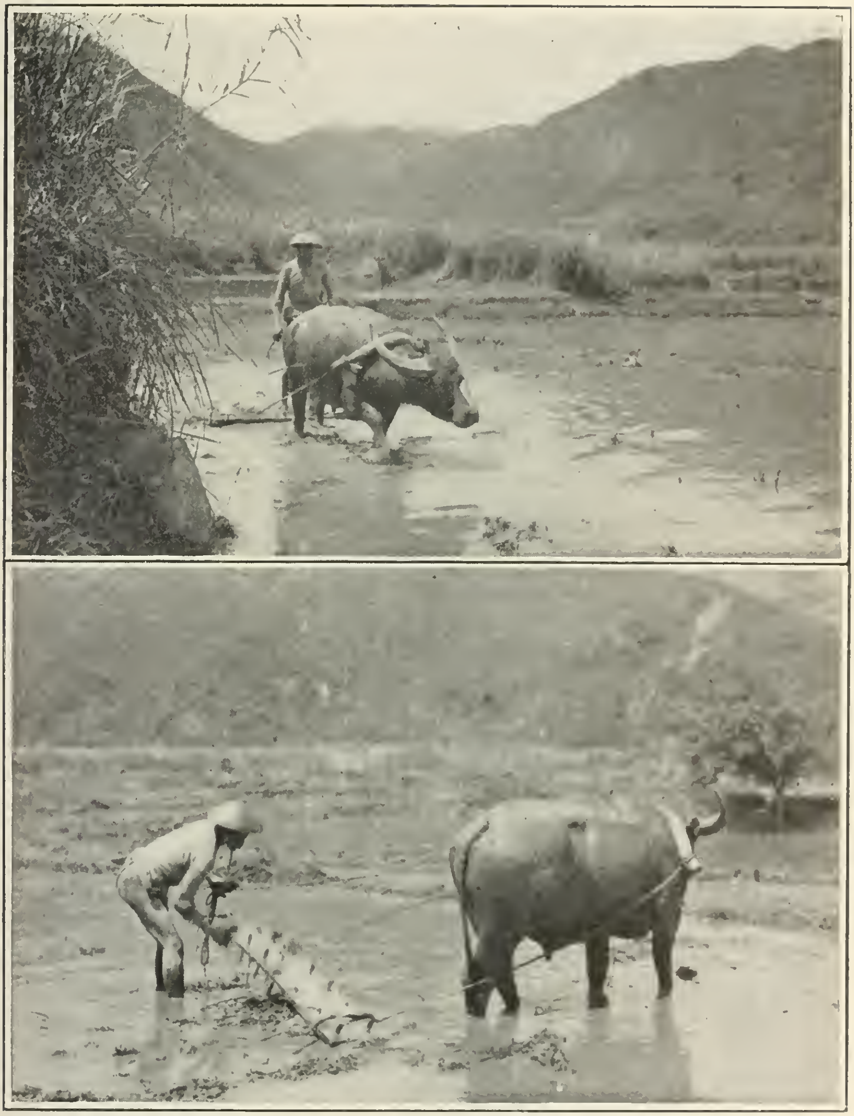
PRIMITIVE MINERAL INDUSTRY.
Igorrote panning gold in a pan made from the bark of a tree.



IGORROTE TRUCK FARMERS.

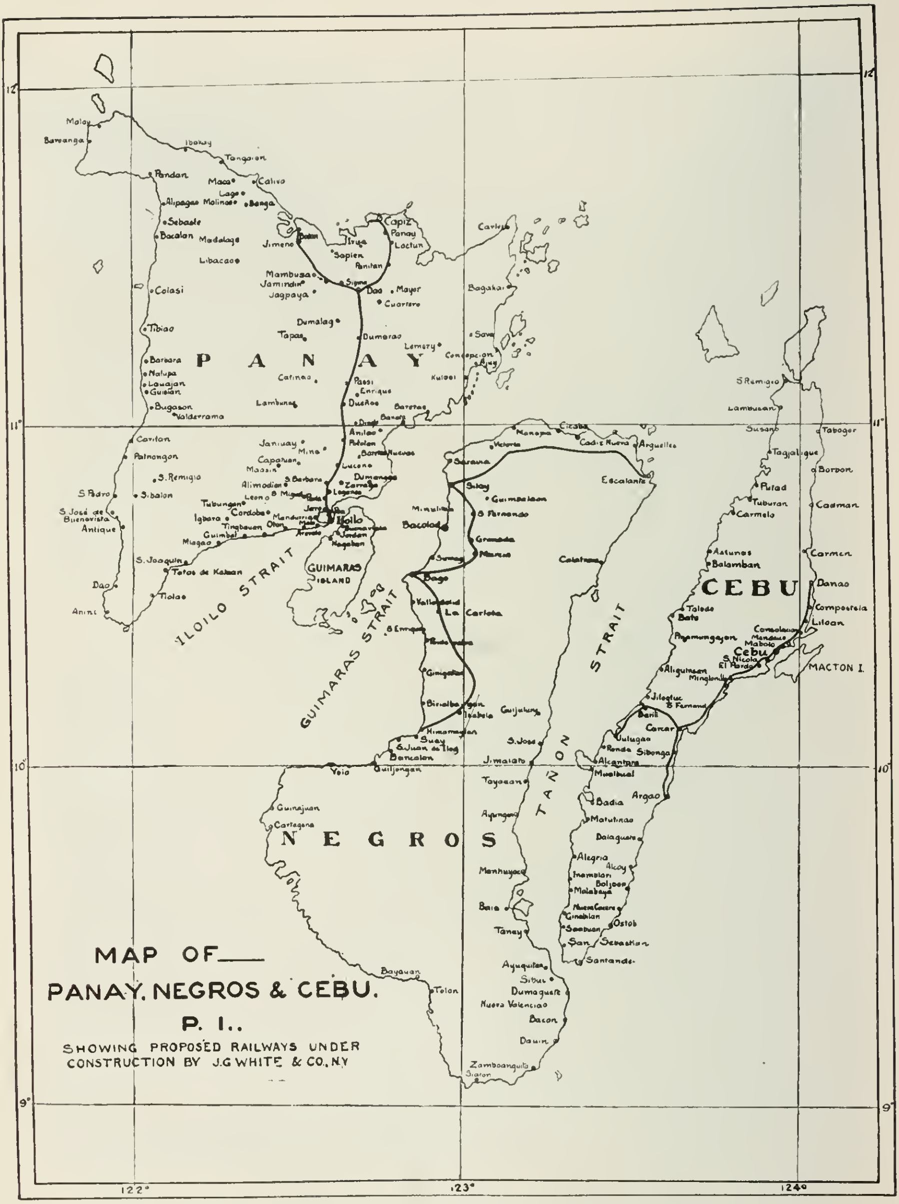
What has been said of the effect upon Philippine sugar growing, of the awakening of China, applies with fully as great force to the other great staple of the islands, hemp—to say nothing of the demands of the rest of the world for that article. One might continue and cite an hundred and one particulars in which China is destined, with diplomatic treatment, involuntarily to aid in the civilization and enrichment of the Philippines, without in a material degree affecting the trade between the United States proper and China.

The crying need is for transportation. There are thousands of square miles of fertile land lying virgin in regions quite free from serious menace by hostile tribes and in which the natives for the most part live peaceful, agricultural lives. I refer to a large portion of Luzon, and to nearly all of the three largest islands of the Visayan group—Panay, Negros, and Cebu.



By courtesy of Mr. Wm. Dinwiddie

CULTIVATING RICE FIELDS WITH WOODEN TOOTHED HARROW PULLED BY CARABAO.



MAP OF THE ISLANDS OF PANAY, NEGROS, AND CEBU

Showing the railways projected and under construction. Scale about 21 miles to the inch.

Because of the pressure of this great necessity for transportation facilities, the insular Government has had under consideration, for some time, definite plans for the inauguration of an extensive system of railroads, looking toward the material betterment of the Filipino; the contract has been finally placed with J. G. White & Company of New York, for the construction and operation for thirty years — operation to become optional thereafter — of 300 miles of road, almost equally divided between Panay, Negros, and Cebu. These are, at the same time, very thickly populated and among the richest in agricultural resources of the Philippine Islands, while Cebu contains certain mineral riches.

It is not inopportune here to digress slightly for the consideration of the general status of modern transportation utilities in the Philippine Islands, indicating at the same time the part thus far played by the natives as workmen, operatives, and patrons.

IGORROTE WOMEN RETURNING FROM THE FIELDS WITH WELL FILLED HEAD BASKETS.

The only steam railway of any magnitude in the archipelago is the Manila & Dagupan Railroad, built chiefly with British capital and by British engineers. The main line was completed in 1894, and, while primitive in the light of the best European and American practice, it is nevertheless a highly important and well-patronized road. The direction is generally north and south, and the terminals are Manila and Dagupan, 122 miles apart. A branch line, 86 miles long, is nearing completion, the terminus being Cabanatuan, an interior town northeast of Manila and east of Dagupan. This line is being built under concessions granted by the insular Government, and will be similar in all cardinal respects to the main line.

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INLAND FREIGHT CARRIAGE, ISLAND OF CEBU

A load of Manila hemp coming to market.

The passenger traffic of this system is over 1,000,000 per year, of whom 95 per cent. travel third class. The freight traffic aggregates about 10,000,000 ton-miles. The gross revenue has averaged from $1,000,000 to $1,250,000 per year, of which nearly 66 per cent is derived from the passenger service. The gross profit is about $400,000

PHILIPPINE PASSENGER TRAFFIC. CHAIR CARRIERS ON THE TRAIL.

per year, on a property valuation, excluding franchise, of $10,000,000. And this has been during the reconstruction period of the government, when traffic was probably but a fraction of what may be expected now that more stable and healthful conditions are established. That the mere presence of the American element has not directly augmented traffic is shown by the maintained high percentage of third-class

CHAIR CARRIERS AND PACKERS RESTING ON A MOUNTAIN TRAIL

THE MOST MODERN MODE OF TRAVEL IN PANAY.

passengers through the period of transition and the almost negligible percentage of first-class, which would include Americans. Still, the business has been altogether more prosperous than during the Spanish sovereignty, despite the disturbed condition.

The gauge of the Manila & Dagupan road is 3 feet 6 inches, the rails weigh from 50 to 60 pounds to the yard, and the ballast is rock and sand. There are nearly three-hundred bridge structures, nearly all of masonry and steel, and the whole line and equipment are in an excellent state of repair. The rolling stock is diminutive and inadequate, but the operation of the line furnishes nevertheless a reliable criterion for the organization of new railroad enterprise. It shows, roughly, in how far assistance and patronage are to be expected of the natives. Operating expenses on the Manila and Dagupan line are only 45 per cent of the total charges. Natives make very cheap and fairly efficient section hands on maintenance of way, and, what is more noteworthy, good locomotive drivers and section foremen. The wages for each class of workmen are from a quarter to a third of what is paid in the United States, and the difference in efficiency does not balance the account.

The entire 200 miles of the Manila and Dagupan system has been

AN ASPECT OF NATIVE PHILIPPINE WATER TRANSPORTATION.

Tame carabao and cocoanut rafts, Pagsanjan River, Manila.

built with native labor but it traverses a district where labor is plentiful. Altogether the assistance given in construction work is satisfactory. In operation the only serious difficulty with the native employees results from a well developed striking propensity. The managers have learned from experience that the best antidote is patience, so work is simply suspended in as far as is necessary, until the strike dies a natural death. The striker generally tires of striking with a readiness quite inconsistent with his apparently always-present readiness to strike.

The volatile temperament of the native is a never-ending source of difficulty to managers of industrial and engineering undertakings in the Islands. Oftentimes this weakness is made stock of by unscrupulous native Government officials to further their own ends, and one can never tell quite how he stands with this gentry. One incident will serve to illustrate the point.

In 1904 I undertook the building of a Government road in northern Pangasinan, a Luzon province. For the purpose a part of what is known as the $3,000,000 Congressional Relief Fund was appropriated. A meeting was arranged between myself and the native provincial

TRANSPORTING ORANGES BY WATER, NEAR MANILA

governor on the one hand, and the town officials on the other, with the object of making clear the nature of this public benefaction. Hearty co-operation was assured us in the undertaking. Work was started under these favorable auspices, with an abundant supply of eager workmen. However, at the end of two weeks, on the day following pay day, there appeared but a paltry seventy men instead of nearly a thousand. This instant change of front of course, indicated the presence of some malign influence, and our suspicions were further aroused by a call from the mayor during which he feigned great surprise and regret at our predicament, and promised his assistance in gathering a new corps. We perceived no result from this promise, and our suspicion was practically confirmed by a subsequent visit of two of the town council. These worthies, after beating all around the bush, came to the point with the statement that our trouble was due

PHILIPPINE WATER TRANSPORT. 20,000 COCOANUTS ON RAFTS IN PAGSANJAN RIVER.

to ignorance in handling native labor, and forwith proposed to manage the matter for us on a contract basis at 30 cents per head per day, the authorized rate. Here was the suggestion of "graft" in all its modern refinement. The rascals even offered guarantee.

We instituted a secret investigation, and fortunately secured to our service an ostensibly honest city father, with whose aid a *dénouement* was effected. Here was presented a fat opportunity to pilfer the devoted federal Government; so it was planned, after having bound us by the contract scheme, to "squeeze" 10 cents daily on the individual wages paid by us. The contented state of the labor was completely revolutionized, by reports surreptitiously circulated, of our inability to pay further wages on account of depletion of funds.

NATIVE LABORERS BUILDING A ROAD THROUGH ROUGH COUNTRY.

We frustrated the machinations of the town fathers when we informed them that our paymaster was bonded to deliver personally the wages of every laborer engaged for the Government work. Then began a long fight between ourselves, determined to build the road, and the local officials, determined to obstruct all progress. They operated by spreading alarmist reports, affirming that we intended to beat and even kill enployees, and to confiscate draught animals

OPENING THE WAY FOR URBAN RAPID TRANSIT.

loaned for the work. We succeeded, nevertheless in mustering an average of four-hundred men on the job, chiefly by kind treatment and prompt payment at frequent intervals. It was never possible to get sufficient evidence to convict the malefactors, as they operated through secret channels and enjoined silence by dire threats of mutilation of the speaking organism of any tale bearer.

A part of the scheme for railroad expansion proposed by the Government consists in an extension of the Manila & Dagupan system amounting to about 400 miles. However, definite arrangements for the construction of these extensions have not yet been made and there is but one bidder for the contract, Speyer & Company, of New York.

Of quite as great importance in the public-service utilities of the Philippines as the Manila & Dagupan Railroad, is the Manila Electric Street Railway, built and now operated by J. G. White & Company, New York. The holding company is the Manila Electric Railway & Lighting Corporation. There are in this system 40 miles of modern, high-grade street railway, which, with the power house and lighting equipment, constitutes the most complete electric service plant in the Far East.

The bonded investment, covering also the value of the plant of the old lighting company, "La Electricista," which has been superseded by the new organization, is $6,000,000. This property, opened to the public on April 15, 1905, was established on a paying basis the first of this year. All the car operatives and many station men are native Filipinos.

It was generally feared that the well-known tendency toward instability in the native character, would manifest itself in this work—probably more exacting than any which natives in numbers had hitherto been called upon to perform. But the results of a year's trial are most satisfactory. The operation of a modern electric street-car in the crowded streets of an oriental city, where traffic and pedestrians are absolutely at variance with and antagonistic to so foreign an element, calls for the full measure of steadiness, tact, and resourcefulness to progress expeditiously without accident. One must have

NATIVE TRACK LAYERS, TRAINED TO AMERICAN TOOLS.

experienced the conditions to appreciate them. The narrow escape of a pedestrian from the wheels of a vehicle is generally acclaimed with delight by all observers, and with derisive equanimity by the principal, who has probably split the last second in estimating his chances. It seems to be one manifestation of the lust for the game of chance which is the besetting sin of most Orientals. Under these circumstances, the almost complete freedom from accident in the operation of the Manila street railway during its inaugural year is a singular commentary on the possibilities of the Filipino character. The conductors, as well as the motormen, have proven their adaptability and, thus far, have discharged their duties with honesty and decorum. I have seen a body of these native motormen and conductors assembled, ready to go on duty, and their businesslike appearance and demeanor are striking. We are accustomed to see in the Filipino face a certain sort of smartness and alertness, but painstaking tutelage has developed the more substantial virtues in these men, if facial lineaments are any indication.

NATIVE FILIPINOS AS LABORERS ON ENGINEERING WORK.

In the installation of this railway and lighting system, it was, of course, necessary to depend upon natives to make up the rank and file of workmen and artisans. In most cases they had to be educated to their tasks,and men who came to the company the rawest of raw

PRESENT METHOD OF DISCHARGING CARGOES FROM LIGHTERS, CEBU.

The completion of harbor improvements and railways on this island will make this a busy port.

laborers, without even knowledge of the use of so rudimentary a tool as the shovel, were turned out finished craftsmen in the course of the work, capable of acquitting themselves creditably as structural-steel workers, and in other skilled lines.

So there is already established, by virtue of these various enterprises, the basis of a skilled working class in the Philippine Islands, which will materially modify the difficulties of the construction of the new railroads. All that has been cited in this reference applies with special force to Luzon, but the effect will undoubtedly manifest itself in the engineering undertakings throughout the archipelago. There is, moreover, a factor of the labor situation that bears directly on the projected railroad work.

A part of the general scheme for developing the resources of the Visayan Islands consist in harbor improvements, along which lines the company that will build the railroads has already carried out important works at Iloilo and Cebu. At these points there have been established modern and fully equipped machine shops, which will no doubt be of inestimable service. In connection with them, there is gathered together a trained working corps of some magnitude on the precise field now to be further exploited.

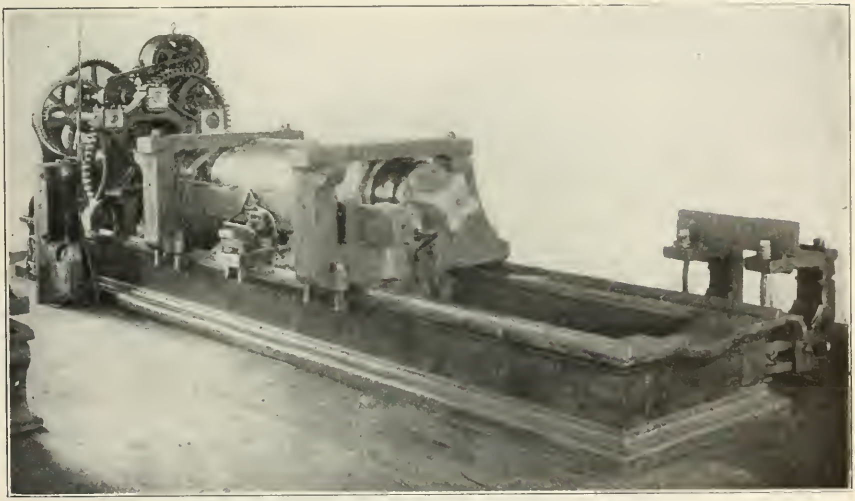
Nearly a million dollars have been expended on these harbor works at Iloilo and Cebu. At Iloilo there have been built stone dikes over a mile long on either side of the Jaro River, terminating in jetties. Between the walls and jetties the river is being dredged to make a uniform channel with a minimum depth of 16 feet and a width of 400 feet. The dredged material is used for filling behind the dikes.

DISCHARGING THE CARGO OF A STEAMER BY CASCOS AND CARABAO CARTS, HARBOR OF CEBU.

The main feature of the Cebu improvements is a concrete sea-wall, a mile long, founded on piles 10 feet below mean low-water level. It is located on the harbor foreshore to form a bund, the material dredged from the harbor being used for filling behind the wall. The dredged depth up to the bund will be 16 feet at mean low-water. In addition, wharves for sea-going ships are being built.

There has been little difficulty with labor on these works in the Visayan Islands. At 30 cents a day for unskilled workmen, the supply has been easily double the demand. The efficiency, despite good intentions, is low. The native, however, will accomplish as much as the white man in that environment, which is about one-third what a white man can do in the United States. The same applies roughly to average skilled labor. In all the industrial centers of the Islands, the average quality of "skilled workmen" is lowered by an element which masquerades under the cognomen, but which has had but a brief and superficial training. This state of affairs is a natural result of rapidly growing demand, and will doubtless be rectified with the further progress of engineering enterprise. As has been already noted, the artisans properly schooled under competent foreigners bear comparison with their white brethren in the field.

The undertakings at Iloilo and Cebu have been materially aided by native officials who, as contrasted with the attitude testified by the incident previously outlined, have pursued a sane and upright policy. Especially at Iloilo the president and governor are most honorable, intelligent, and sensible officials, who know their people and do only what is best for their interests. Their aid is highly valued.



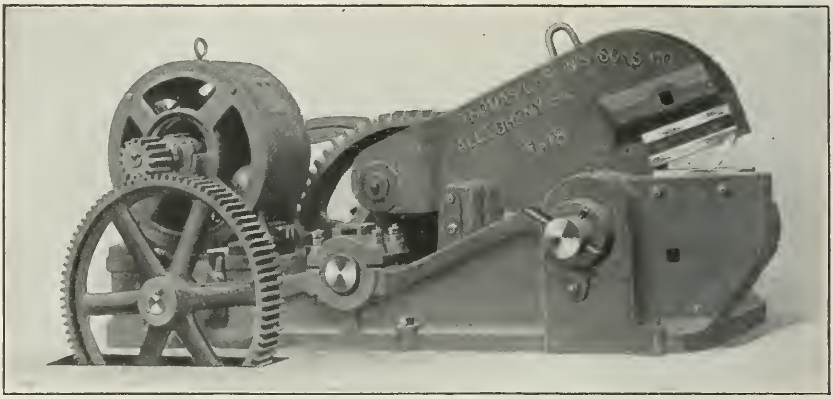
A ROLL LATHE DRIVEN BY ELECTRIC MOTOR.

SPEED CHARACTERISTICS AND THE CONTROL OF ELECTRIC MOTORS.

By Charles F. Scott.

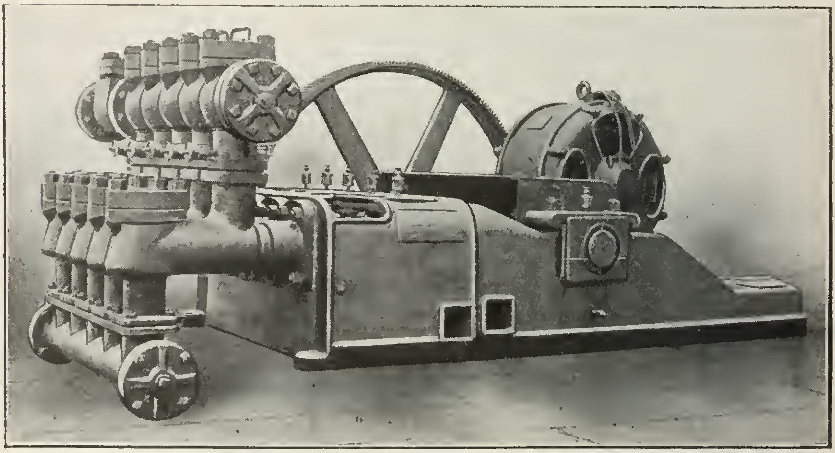
IN the preceding article the general characteristics of speed control of electric motors have been discussed, and particular consideration has been given to the characteristics of direct-current motors. Consideration will now be given to motors which are operated on alternating-current circuits.

The number of kinds of supply circuits for the operation of alternating-current motors is far greater than that for direct-current motors. Direct-current motors are, in general, supplied with current at approximately 110, 220, or 500 volts. Circuits for supplying alternating-current motors likewise differ in voltage and, in addition, they differ in frequency and in the number of phases supplied to the motor. Alternating-current motors are wound ordinarily for approximately 100, 200, 400, or 550 volts, and motors of large size are wound for pressures of 1,000 or 2,000 volts or higher. The greater range of voltages for which alternating-current motors are wound is made possible by the characteristics possessed by alternating-current apparatus. The

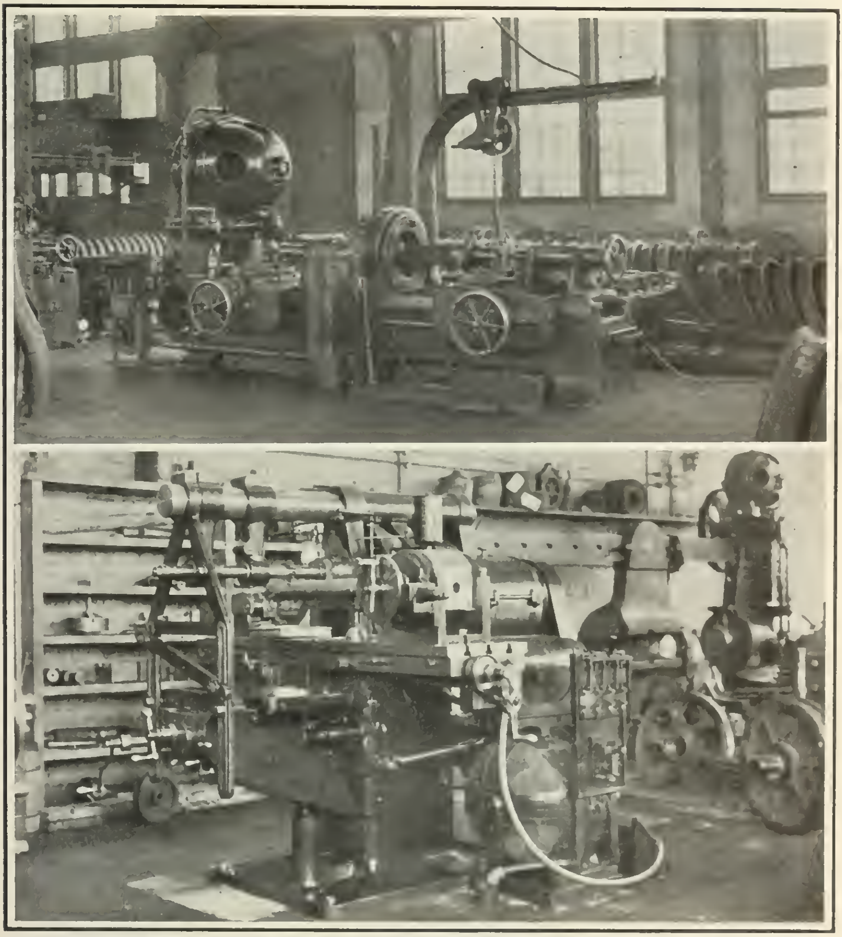


ALLIGATOR SHEAR DRIVEN BY WESTINGHOUSE MOTOR.

motor windings can easily be adapted for different voltages; in fact, in many cases motor windings may be divided into halves, which may be connected in parallel or in series, thereby adapting the motor for operation for either of two voltages, one of which is twice the other. A direct-current motor, on the other hand, has a commutator which does not permit changes in the armature winding and which adapts the motor for one particular normal voltage. The difficulty in commutation at high pressures, moreover, does not make practicable the operation of a direct-current motor at pressures much above 500 or 600 volts. The alternating-current motor has no such limitation and can be wound for much higher voltages, the principal requirement being a suitable increase in the insulation of the winding. While the design



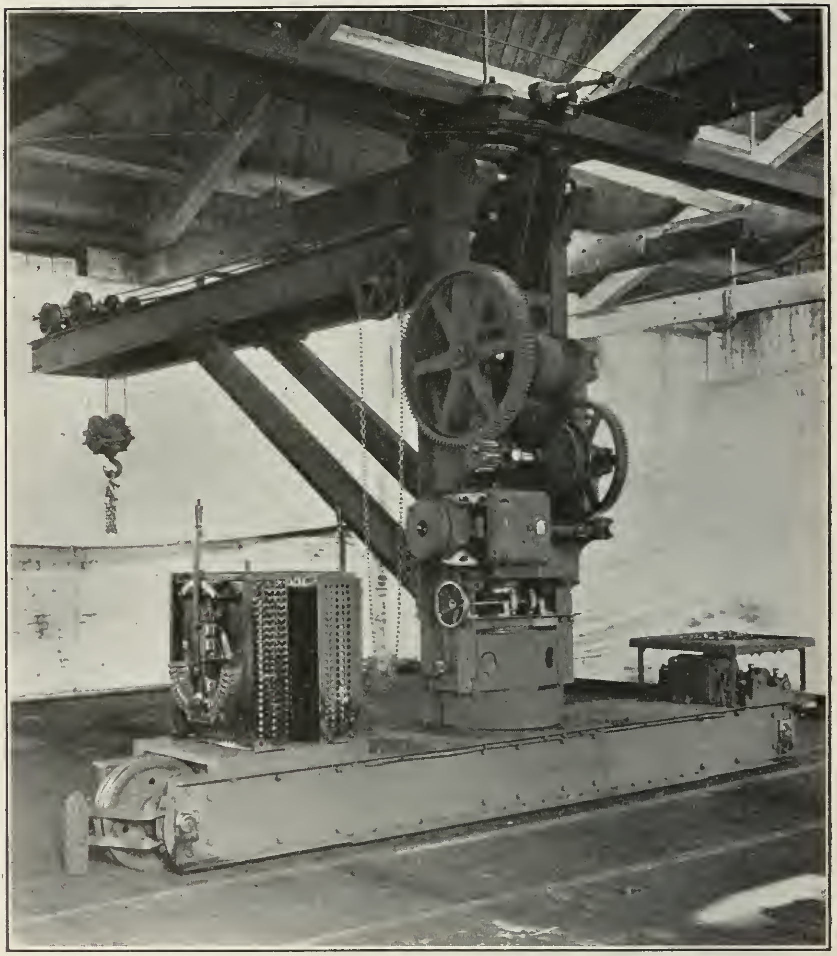
BYRON-JACKSON MINING PUMP DRIVEN BY WESTINGHOUSE MOTOR.



EXAMPLES OF MODERN ELECTRIC-MOTOR TOOL EQUIPMENT.
The upper figure shows an axle lathe with Crocker-Wheeler motor multiple-voltage control in the P. & L. E. R. R. shops; the lower is a milling machine similarly driven.

of the motor itself can be readily adapted for any voltage over a wide range, on the other hand the supply circuit has an elasticity which is not possessed by direct-current apparatus, through the agency of the transformer. Generally speaking, a transformer may be wound with equal facility for giving any definite voltage, thus allowing the selection of the pressure best suited to a particular installation. Motors not exceeding 50 or 75 horse power are usually wound for voltages not exceeding 550; and motors of several hundred horse-power capacity are usually wound for higher voltages.

In addition to differences in voltage, circuits differ in frequency. This may be expressed either in alternations-per-minute, which gives



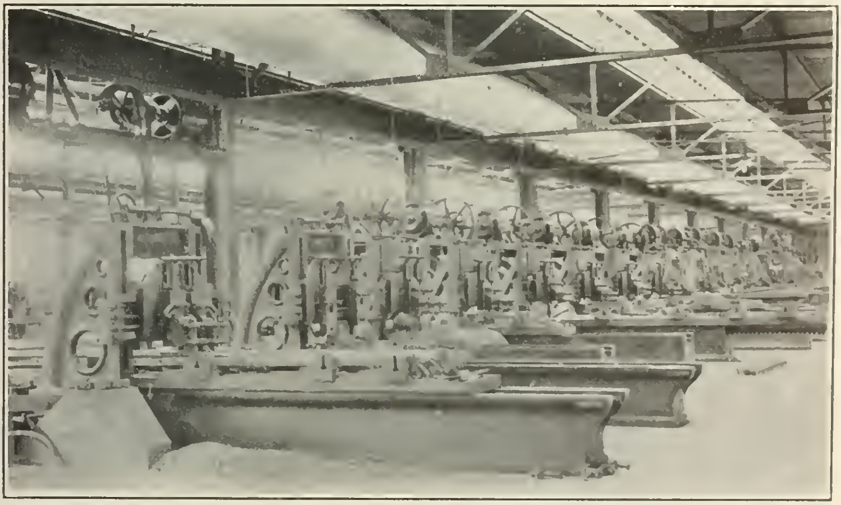
AN ELECTRICALLY OPERATED TRAVELING JIB CRANE.

Northern Electric Mfg. Co.'s box-type motor. Crane by Case Mfg. Co., Columbus, Ohio.

the number of reversals in the direction of the current per minute, and is equal to the number of field poles of the alternator multiplied by its speed in revolutions-per-minute; or, the frequency may be given in cycles-per-second, one cycle comprising two alternations. The most common frequencies are 3,000 alternations, or 25 cycles; and 7,200 alternations, or 60 cycles. These frequencies include a very large proportion of the alternating-current systems in use in the United States, and very few new plants are installed in which any other frequency is adopted. In other countries, however, frequencies intermediate between these standards are employed.

SLOTTER AND SHEARS, PITTSBURG & LAKE ERIE R. R. SHOPS.
Made by Hilles & Jones Co., and equipped with Crocker-Wheeler electric motors.

Another characteristic of alternating-current circuits is found in the number of phases which they supply. Single-phase circuits supply a simple alternating current. Polyphase circuits employ more than two wires and supply two or more currents, differing in their phase or time relation. The two classes are: two-phase circuits, in which there are two alternating currents differing in phase by 90 degrees; and three-phase circuits, which have three currents differing by 120

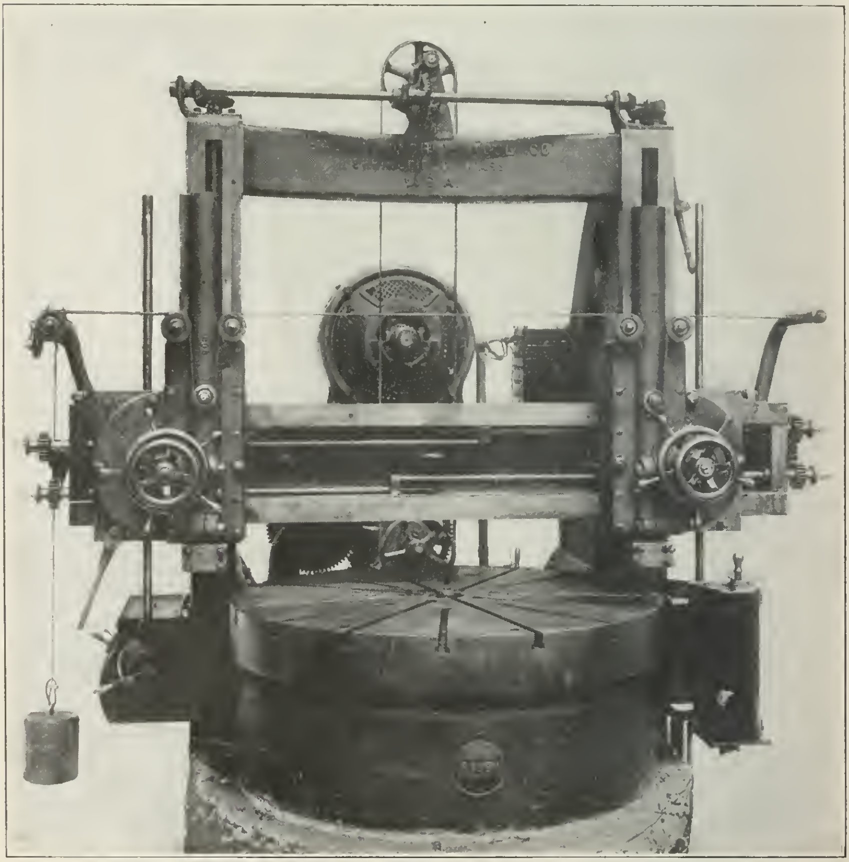


A ROW OF ELECTRICALLY DRIVEN PLANERS IN THE WEIR FROG COMPANY'S SHOPS.
Built by American Tool Co., and equipped by Allis-Chalmers Co

degrees. The general relations between these three varieties of action may be illustrated by three types of reciprocating engines, namely, single-crank; two-crank, with the cranks set at 90 degrees; and three-crank, with the cranks set at 120 degrees.

In a given plant the frequency is fixed by the number of poles and the speed of the generator, which is constructed to give a definite number of phases. The number of phases and the voltage admit of change by means of transformers. Usually, however, all the motors in a given installation are made for a definite number of phases and a definite voltage. The choice of frequency and other characteristics is made when the plant is first designed.

The speed torque characteristics of alternating-current motors are essentially the same whether the motor be wound for high or for low voltage, for two or for three phases, or for high or for low frequency.

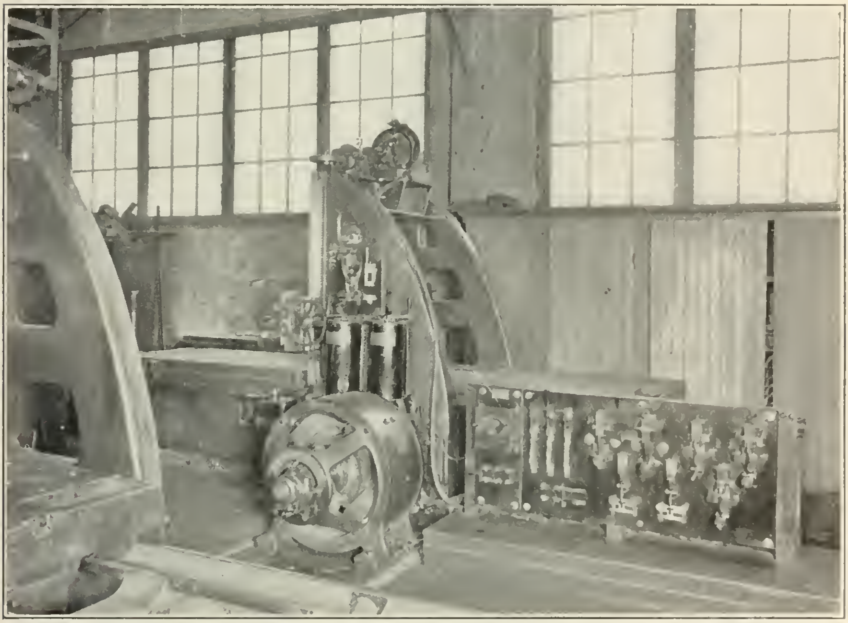


BAUSH BORING MILL DRIVEN BY WESTINGHOUSE MOTOR.

Types of Alternating-Current Motors.

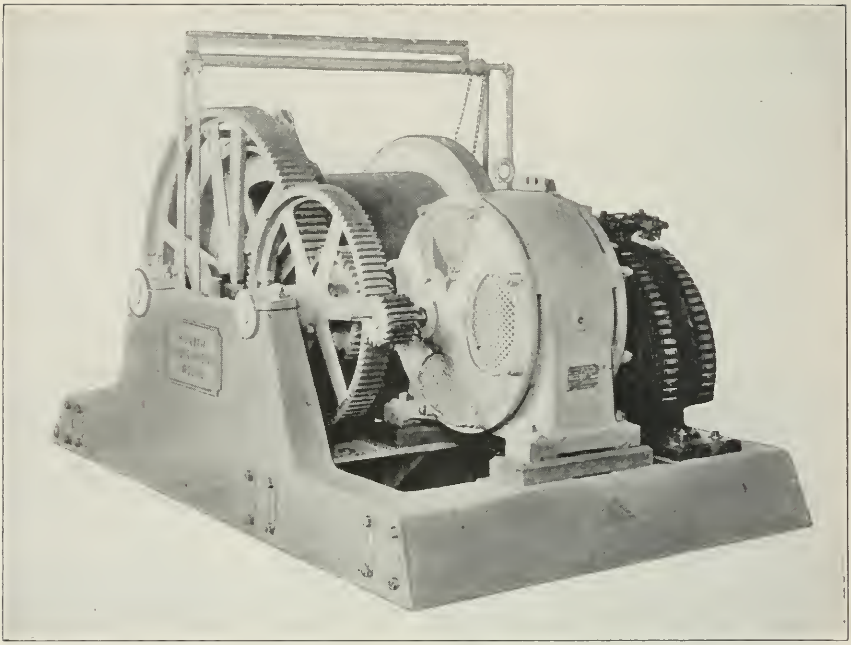
Alternating-current motors are of several types, the principal characteristics of which will be briefly discussed.

The synchronous motor operates at an absolutely definite speed, which is in a definite ratio to the speed of the generator which drives it, and is dependent upon the relation of the number of field poles in one machine to that in the other. This motor is used principally in large sizes, and is not generally employed in small units in the general distribution of power. It usually requires an auxiliary exciting current and a greater degree of care in attendance than is necessary with other types of motors. It admits of no speed variation unless the speed of the generator is changed. It is not self-starting with load.

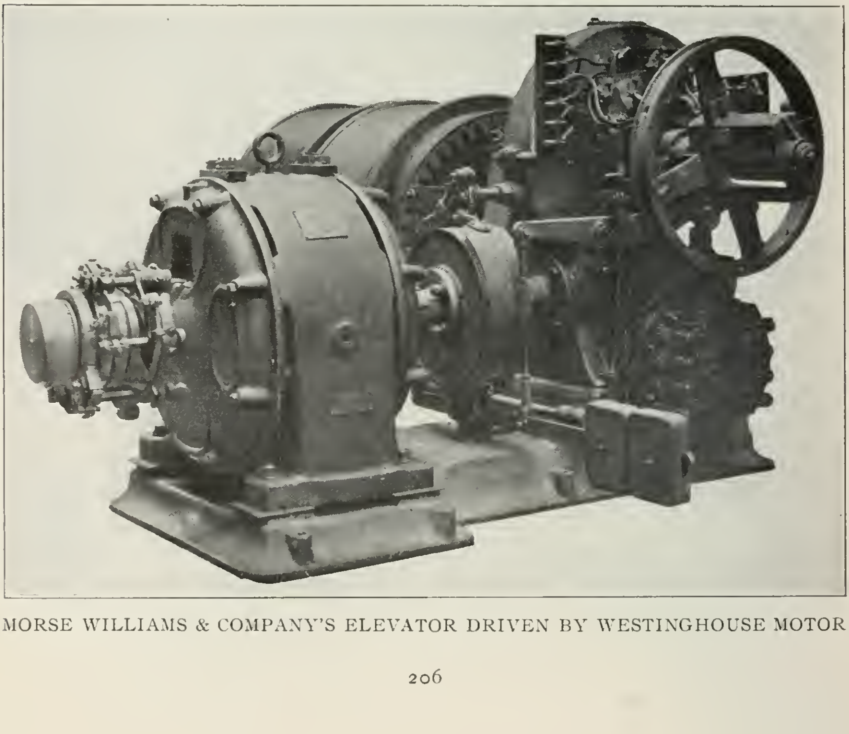


POND PLANER, 36 BY 36 INCHES BY 12 FEET, WITH ELECTRIC CONTROLLER & SUPPLY COMPANY'S DIRECT-CONNECTED VARIABLE-SPEED MOTOR DRIVE, SHOWING DETAILS OF CONTROLLERS.

The polyphase induction motor is so well known that it needs no extended description. There are several common types of induction motors. The first is provided with a rotating secondary of the squirrel-cage form, the winding of which consists of a number of copper rods laid in slots in the core and connected at each end to metal rings. This motor tends to run at a definite speed, depending upon the

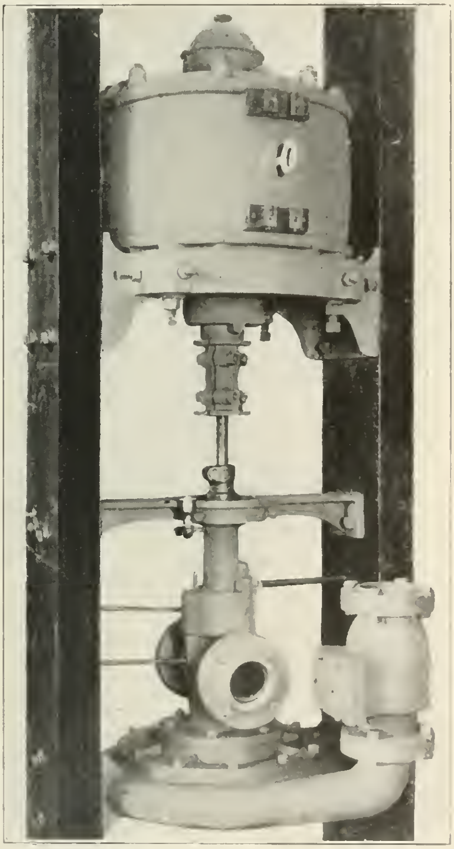


DENVER ENGINEERING WORKS' HOIST DRIVEN BY WESTINGHOUSE MOTOR.

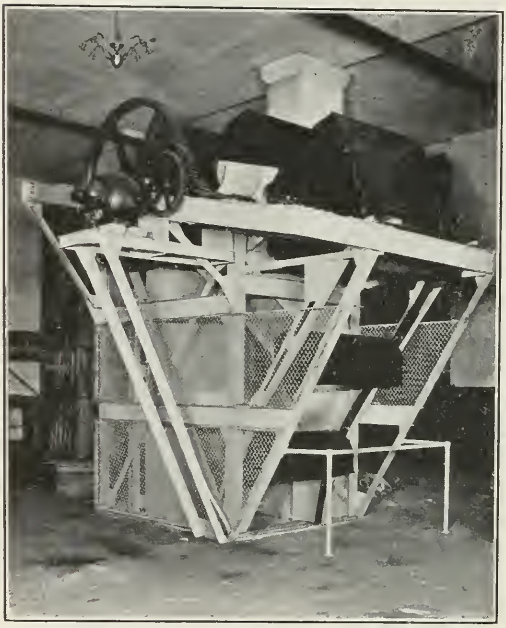


MORSE WILLIAMS & COMPANY'S ELEVATOR DRIVEN BY WESTINGHOUSE MOTOR number of its poles and the frequency of the circuit from which it receives its current. The actual speed approaches very close to the theoretical speed at no load and falls off from it as the motor is loaded. If the end rings to which the bars on the secondary are connected have a low resistance, then the speed decreases but slightly with load, and the motor is practically a constant-speed motor. Its running characteristics are quite similar to those of the direct-current shunt motor, except that the normal speed of the latter may be varied by changes in its field strength, whereas the induction motor has but one definite speed.

If the induction motor has end rings of relatively high resistance, then the speed falls off to a marked degree as the motor is loaded. The characteristics of this motor correspond approximately to those of a direct-current shunt motor having a resistance connected into its armature circuit. A direct-current motor under these conditions has a decreasing electromotive force upon its armature terminals, and, consequently, a decreasing speed with increase of load. An induction motor with high-resistance end rings may be proportioned so as to give an increase in torque with lowered speed until a maximum torque is reached at rest. The starting torque, and likewise the torque at any definite speed, is dependent upon the electromotive force applied to the motor. At a reduced electromotive force there is a reduced torque. If the motor be supplied with a controller, by which different electromotive forces may be applied to the motor, the motor is under com-



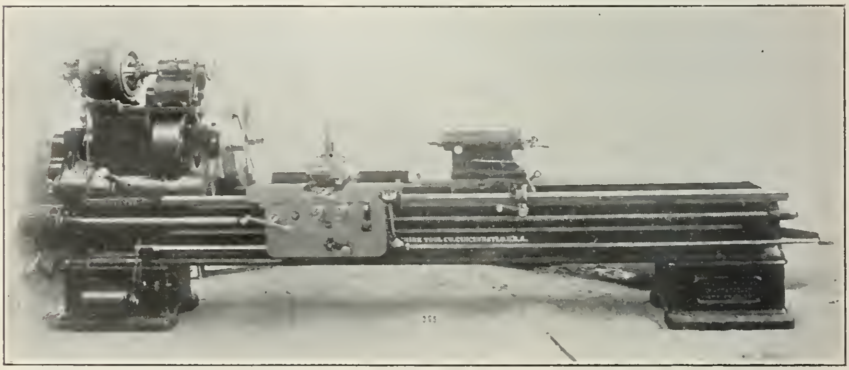
BYRON-JACKSON CENTRIFUGAL SINKING PUMP OPERATED BY WESTINGHOUSE MOTOR.



NORTHERN ELECTRIC MOTOR DRIVING JEFFREY ELEVATOR, HANDLING MAIL IN THE CHICAGO POST-OFFICE.

plete control for variable-speed work, such as hoisting and the like, as it may develop any torque at any speed over a wide range. The speed conditions, however, are unstable, and a change in load will result in a change in speed.

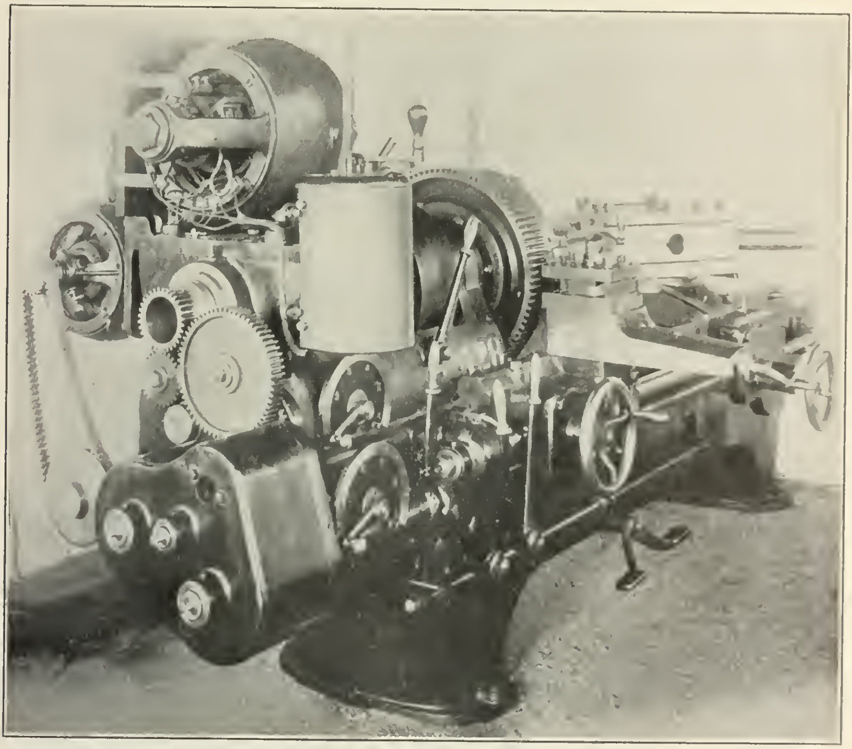
An induction motor may be constructed with a rotating secondary having a continuous winding which is connected to collector rings from which the current is conducted to a rheostat. By adjustment of this rheostat, the characteristics of the motor may be varied from those of a motor having a high secondary resistance to those of a motor having a low resistance; that is, from a motor which gives large changes in speed with change in load to one which has very small speed variations with change in load. This resistance in the secondary circuits is equivalent to a variable resistance in the armature circuit of a shunt motor. The analogy between the



A METHOD OF MOUNTING THE CONTROLLER ON AN ELECTRICALLY DRIVEN MACHINE TOOL.

The controller (Cutler-Hammer System) on the left is operated from the post by means of shaft, chain, and sprockets.

two includes the relation between efficiency and speed. Under any condition of speed, the total power which is received by the rotating secondary appears as internal losses and as mechanical energy developed. The mechanical energy is proportional to the speed. For example, if the speed be 90 per cent of that at no load, then the mechanical energy developed is 90 per cent. The control of an induction motor by resistance in the secondary is useful in starting the motor, and for various conditions requiring speed control, particularly where the motor is under the control of an attendant, and in which the proportion of operation at slow speed is small.



CUTLER-HAMMER DRUM CONTROLLER MOUNTED ON THE TOOL WITHIN REACH OF THE OPERATOR.

Characteristic curves of an induction motor are given in Figure 3. The horizontal scale is plotted in pounds-torque at one foot radius and the vertical scale in speed and horse power. The various speed curves correspond to different amounts of resistance in the secondary circuit, the various resistances being introduced or cut out by placing the controller handle on successive notches. On the first notch the resistance is a maximum and the torque developed is therefore relatively small. The torque is maximum at starting and decreases uniformly as the speed increases. If the controller handle be moved to the second notch the torque corresponding to any speed is increased. When the secondary is short-circuited the torque corresponding to a given speed is a maximum. This statement, however, does not apply at low speeds, as the torque reaches the maximum and then falls off. As the torque decreases the speed approaches a certain definite maximum. It will be noted that the upper curve showing the condition with the secondary short-circuited is approximately a constant-speed curve, as the fall in speed is slight until a considerable torque is attained.

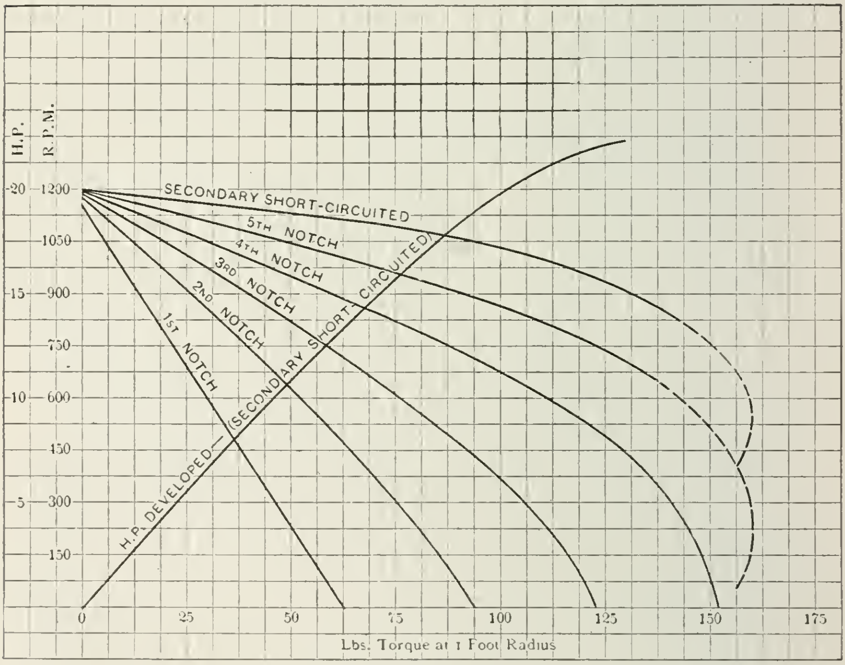
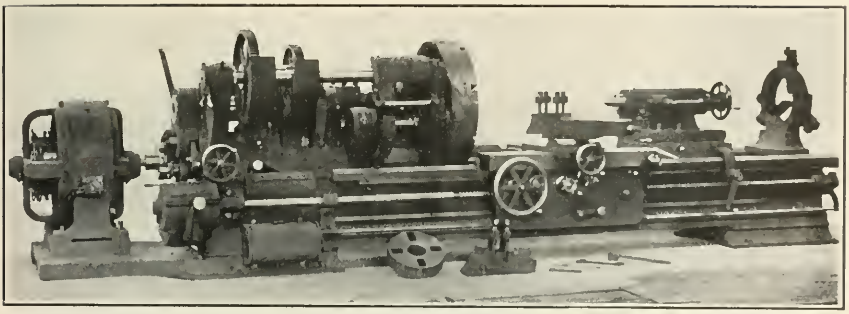


FIG. 3. CHARACTERISTIC CURVES OF AN INDUCTION MOTOR.

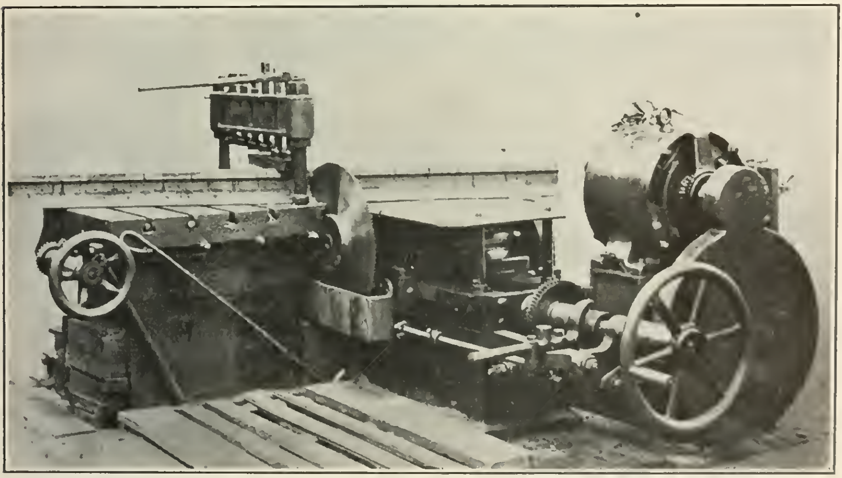
The group of speed-torque curves for the induction motor shows that over a considerable range various relations between speed and torque can be secured. If the motor is carrying a load with resistance in the secondary circuit, a change in load will cause a change in speed. This method of control by the introduction of resistance in the secondary is in many respects quite similar to the control of a shunt motor by resistance in its armature circuit. The variation of speed with load, the relative performance with different amounts of resist-



GENERAL ELECTRIC MOTOR DRIVING A 36-INCH SHIPLEY LATHE.
Direct-current, 220-volt, 20 h. p. motor, 550-1500 revolutions.

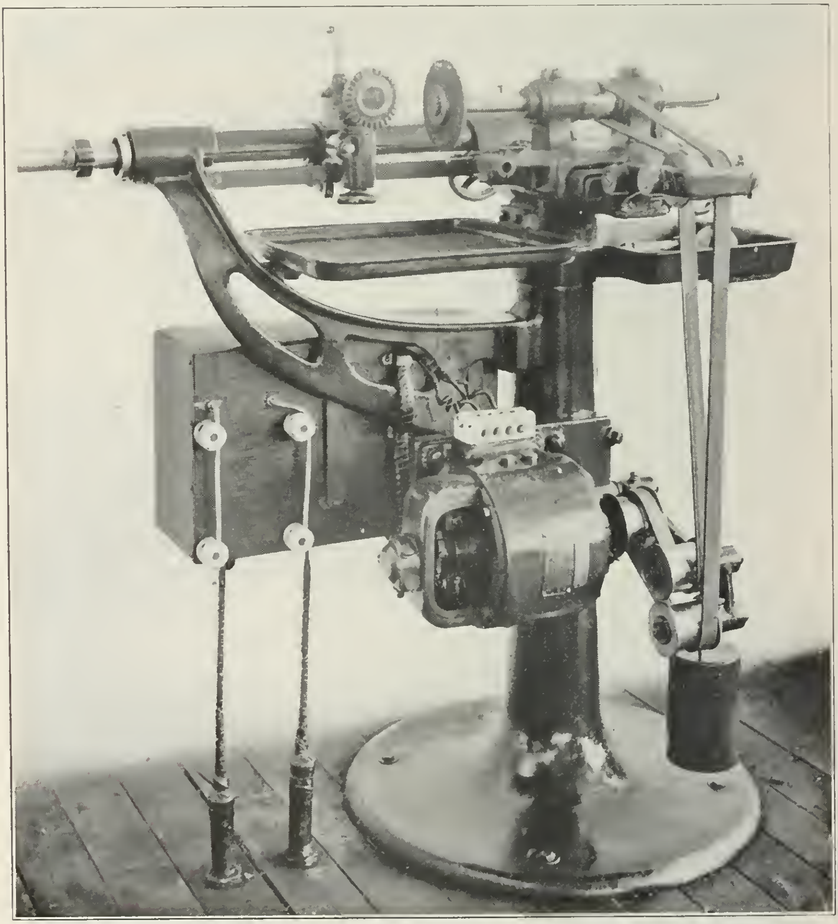
ance in circuit, and the relation between losses in the resistance and the useful power developed correspond closely in the two cases. This comparison is useful in a general consideration of the performance of the induction motor as direct-current operation is more easily understood than is the alternating-current motor, as one is apt to be confused by the consideration of phases, power factors and the like, which have little to do with the speed-torque relations.

There are certain special forms and methods of operating induction motors which give speed characteristics other than those of the simple form of motor which has been considered in the foregoing paragraphs. A multi-speed induction motor may be obtained by placing on the motor two windings for different numbers of poles. A



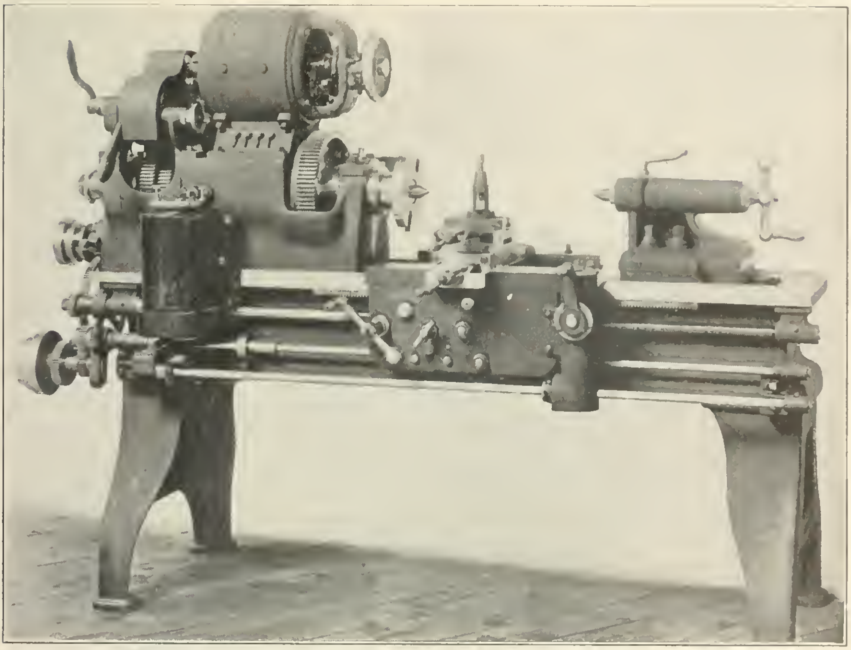
NEWTON CUTTING-OFF SAW DRIVEN BY ALLIS-ÇHALMERS MOTOR.
Shops of the Weir Frog Co.

winding having twice as many poles as another winding will give half the speed. The second winding may be entirely independent of the first, or the same coils may be employed and the connections between them may be changed by means of a switch or controller so as to produce either four poles or eight poles, thereby affording either of two speeds. A change of this kind has its mechanical equivalent in a change in gear ratio.



GENERAL ELECTRIC MOTOR DRIVING BROWN & SHARPE TOOL GRINDER.

Another method of obtaining a second speed by means of induction motors requires two motors with provision for supplying current for the second motor from the rotating secondary of the first motor. If the two motors have the same number of poles then the speed

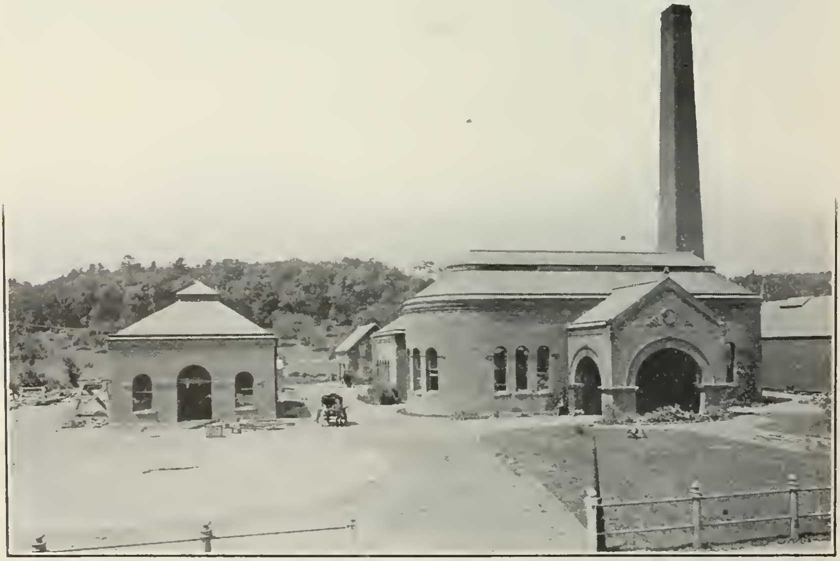


REED 16-INCH LATHE RUN BY GENERAL ELECTRIC MOTOR.
One horse power; speed variable from 500 to 1,500 revolutions.

when connected in tandem is one-half. The method is employed in railway work, in which the motors are connected in tandem for starting and then may be connected independently to the supply circuit for running at full speed. This method, however, has very little field of application, particularly for small amounts of power.

Alternating-current motors with commutators have, in a general way, characteristics similar to those of direct-current motors. The single-phase series motor is being introduced for railway work. Motors of the same type are suitable for the operation of hoists, cranes, and the like, and have approximately the same characteristics as direct-current series motors. It is likely that commutator motors will, in the future, have an increased and important application aside from electric traction.

A popular review of the speed characteristics of motors must be quite general if it is to avoid a maze of details and special constructions. During the past few years there has been a great amount of designing to meet specific conditions. Motors are made to have various ranges of speed and with the particular torque curves which best fit them for operating elevators or pumps or bending rolls or other specific service. The same motor in electrical construction is made in different mechanical forms. The degree of this specific adaptation to particular conditions is most strikingly shown by comparing the motors which are now available with the standard motors of ten years ago. One of the large electric companies at that time did practically all of its stationary direct-current motor business with a "standard-speed" and a "slow-speed" motor. Instead of these two kinds, it now offers motors for a given output which are made in ten or a dozen mechanical forms, such as open, semi-closed, enclosed, vertical shaft, one, two or three bearings, with back gear, with idler pulley, inverted and side mountings for ceiling or wall suspension and the like. These different forms are wound for a great variety of speeds and speed ranges. For the field which was covered a few years ago by a dozen motors, there are now hundreds, each adapted to particular conditions, and even yet cases are continually arising which call for new designs.



AN EXAMPLE OF ELECTRIC-DRIVEN AS COMPARED WITH STEAM-DRIVEN MACHINERY.

Rotterdam, N. Y., Water-Works. The electric pumping station on the left has a capacity of 24,000,000 gallons daily; the steam pumping station on the right, of 12,000,000 gallons daily. Electric equipment supplied by the General Electric Company

A STOCK-KEEPING SYSTEM FOR GENERAL STORES.

By F. W. Jessop.

The system described by Mr. Jessop, like others which have been presented in preceding articles in this series, is in actual successful use under the immediate direction of the author. The demonstration is therefore as practical as the methods themselves. In the case of the Electric Controller & Supply Co., of which Mr. Jessop is Superintendent of Production, the stores department is particularly interesting because of the notable efficiency with which it cares for a multiplicity of small parts.—THE EDITORS.

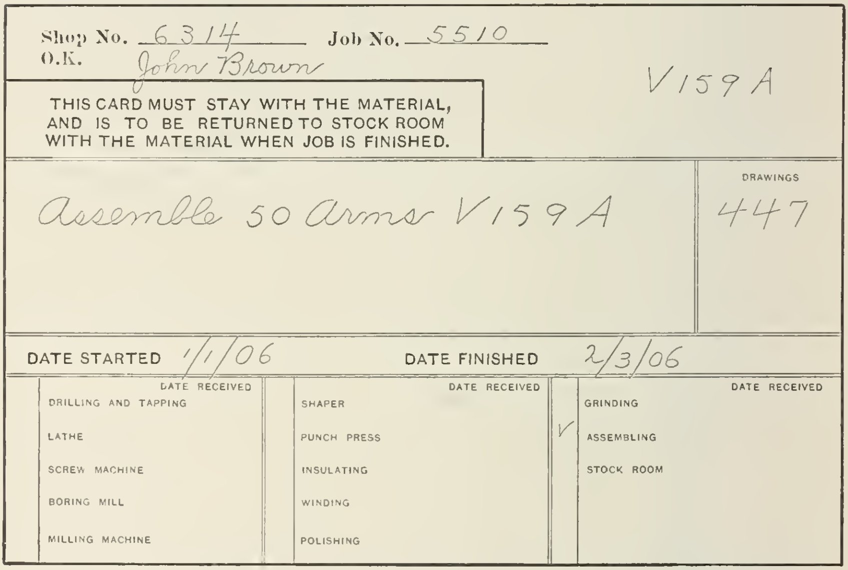
ALMOST the entire product of the company whose store-room methods are here described goes to steel mills, blast furnace plants, iron and steel foundries, and similar industries. It consists mainly of controlling apparatus and friction brakes for reversing motors, and of lifting magnets.

A series reversing motor is absolutely at the mercy of the operator, except where controlling apparatus designed to limit overloads is used; hence it is evident that no other apparatus in a mill is so liable to injury as the motors and controllers. This explains the existence in every large city of companies prepared to furnish commutators and armature and field coils for all standard makes of motors on short notice; it also has led The Electric Controller & Supply Co. to be prepared at all times to ship renewals for wearing parts of controlling apparatus promptly, and to ship controllers complete in from fifteen to thirty days from receipt of the order.

To accomplish this, it is essential that the order be interpreted correctly and transmitted to the shop with all necessary information, that job cards and stock be issued to the shop promptly, and that the shop work be so conducted that, at this stage, practically nothing is required but to assemble, test, and ship.

To this end, we have adopted a system of order-quantities and of low limits in raw stock, finished parts, and assembled parts, based on the monthly requirements but in many cases affected by economies in buying and manufacturing. This system is described further on.

Customers' Orders. When an order calls for special apparatus, the purchasing agent, who also has charge of stock and of the shop office, orders all necessary raw material not carried regularly—patterns, castings, etc.—after which the order takes the same course as an order for standard apparatus, except that he usually indicates how he wishes the work issued to the shop so as to give suitable subdivision of the costs for the benefit of the sales department. Forms A, B, C, and D are used to issue a job to the shop and, as shown, they call for 50-V-159A controller arms.



Shop No. 6314 Job No. 5510
O.K. John Brown

THIS CARD MUST STAY WITH THE MATERIAL, AND IS TO BE RETURNED TO STOCK ROOM WITH THE MATERIAL WHEN JOB IS FINISHED.

V159A

Assemble 50 Arms V159A

DRAWINGS 447

DATE STARTED 1/1/06 DATE FINISHED 2/3/06

		DATE RECEIVED			DATE RECEIVED			DATE RECEIVED
	DRILLING AND TAPPING			SHAPER			GRINDING	
	LATHE			PUNCH PRESS		✓	ASSEMBLING	
	SCREW MACHINE			INSULATING			STOCK ROOM	
	BORING MILL			WINDING				
	MILLING MACHINE			POLISHING				

The Engineering Magazine

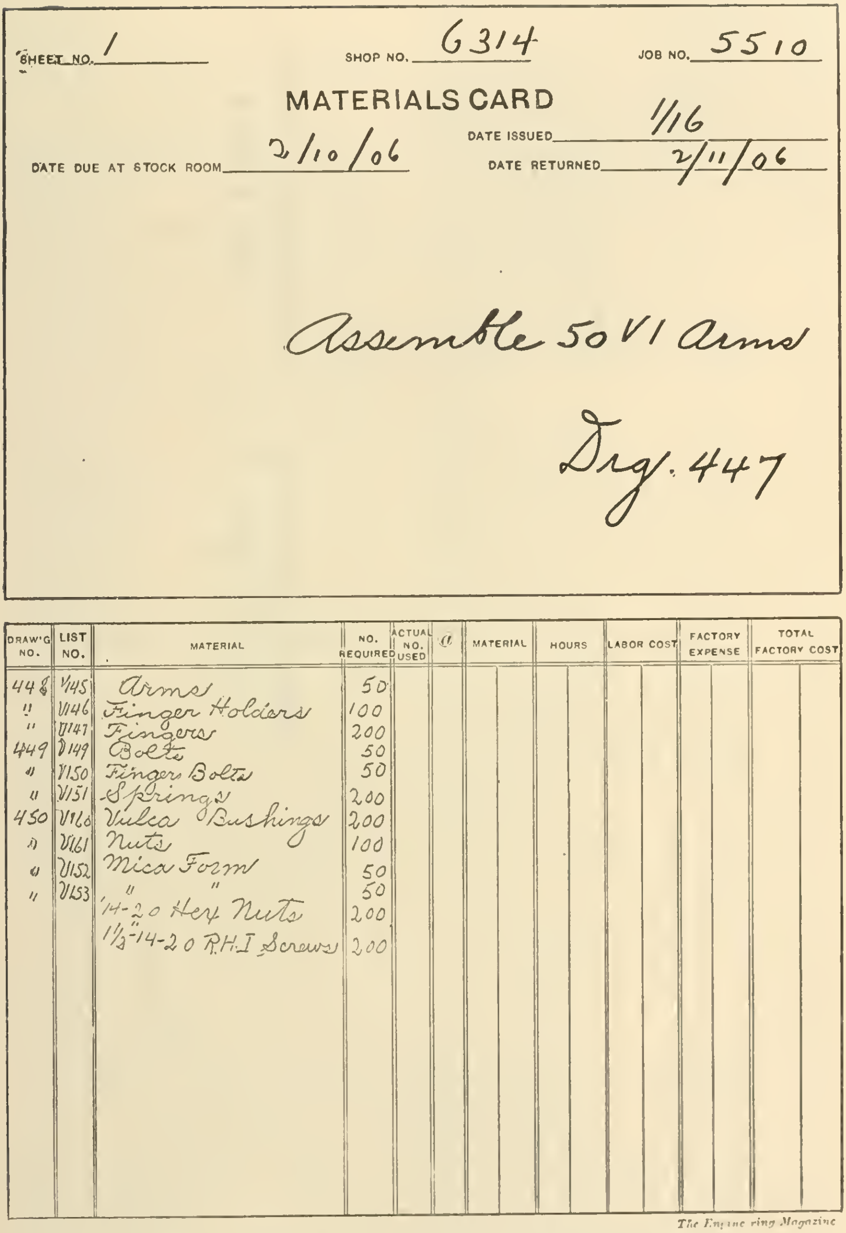
FORM A. WORKMAN'S AUTHORIZATION FOR BEGINNING A JOB.

Original is 6 by 4 inches in size.

Form A is the workman's authority to work on the job; it follows the material to its completion and is returned to the stock room with the finished stock. This form also indicates the rotation of work in the shop. Form B, not shown, is a partial carbon copy of form A and is filed numerically for reference purposes only. It contains only the shop and job numbers, the list number, and the memorandum "Assemble 50 V-159A."

Form C on its face is a copy of Form A, and on the reverse side, as shown, contains a list of the raw and finished stock required. It is kept in the office until the job is completed. Form D, not shown, is a carbon copy of the reverse side of Form C, but with the ruling to the right replaced by a single wide column "Actual No. Used."

When the job is assigned by the superintendent, Forms A and D are sent to the stock keeper and are his authority to issue the stock, D showing the stock required. Practically all stock is issued in this



SHEET NO. 1 SHOP NO. 6314 JOB NO. 5510

MATERIALS CARD

DATE ISSUED 1/16

DATE DUE AT STOCK ROOM 2/10/06 DATE RETURNED 2/11/06

Assemble 50 V1 Arms

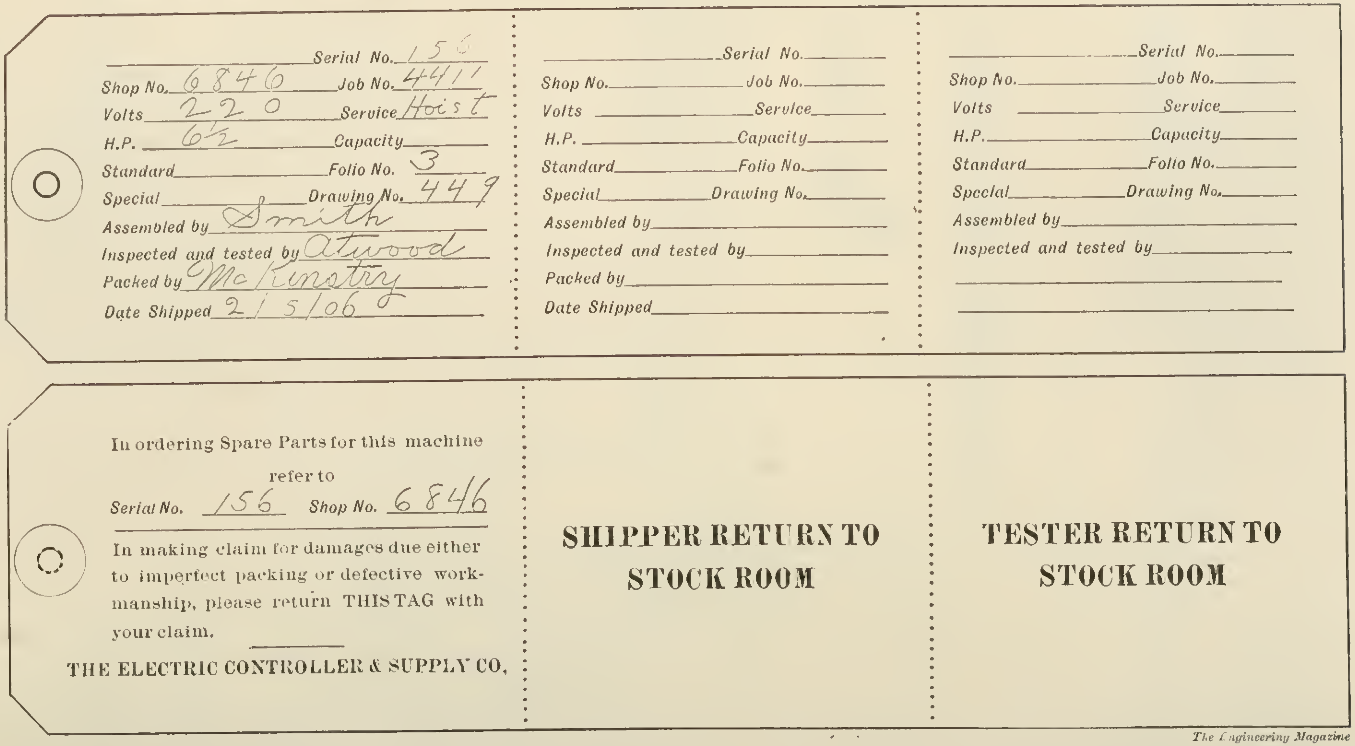
Drg. 447

DRAW'G NO.	LIST NO.	MATERIAL	NO. REQUIRED	ACTUAL NO. USED	@	MATERIAL	HOURS	LABOR COST	FACTORY EXPENSE	TOTAL FACTORY COST
448	V145	Arms	50							
"	V146	Finger Holders	100							
"	V147	Fingers	200							
449	V149	Bolts	50							
"	V150	Finger Bolts	50							
"	V151	Springs	200							
450	V160	Vulca Bushings	200							
"	V161	Nuts	100							
"	V152	Mica Form	50							
"	V153	" "	50							
		¼-20 Hex Nuts	200							
		1½"-¼-20 R.H.I Screws	200							

The Engineering Magazine

FORM C. OFFICE RECORD OF JOB COVERED BY FORM A.

The upper figure is the face, the lower, the back.
Original is 9 by 6 inches.



Serial No. 156
Shop No. 6846 Job No. 4411
Volts 220 Service Hoist
H.P. 6½ Capacity
Standard Folio No. 3
Special Drawing No. 449
Assembled by Smith
Inspected and tested by Atwood
Packed by McKinstry
Date Shipped 2/5/06

Serial No.
Shop No. Job No.
Volts Service
H.P. Capacity
Standard Folio No.
Special Drawing No.
Assembled by
Inspected and tested by
Packed by
Date Shipped

Serial No.
Shop No. Job No.
Volts Service
H.P. Capacity
Standard Folio No.
Special Drawing No.
Assembled by
Inspected and tested by

In ordering Spare Parts for this machine refer to
Serial No. 156 Shop No. 6846

In making claim for damages due either to imperfect packing or defective workmanship, please return THIS TAG with your claim.

THE ELECTRIC CONTROLLER & SUPPLY CO.

SHIPPER RETURN TO STOCK ROOM

TESTER RETURN TO STOCK ROOM

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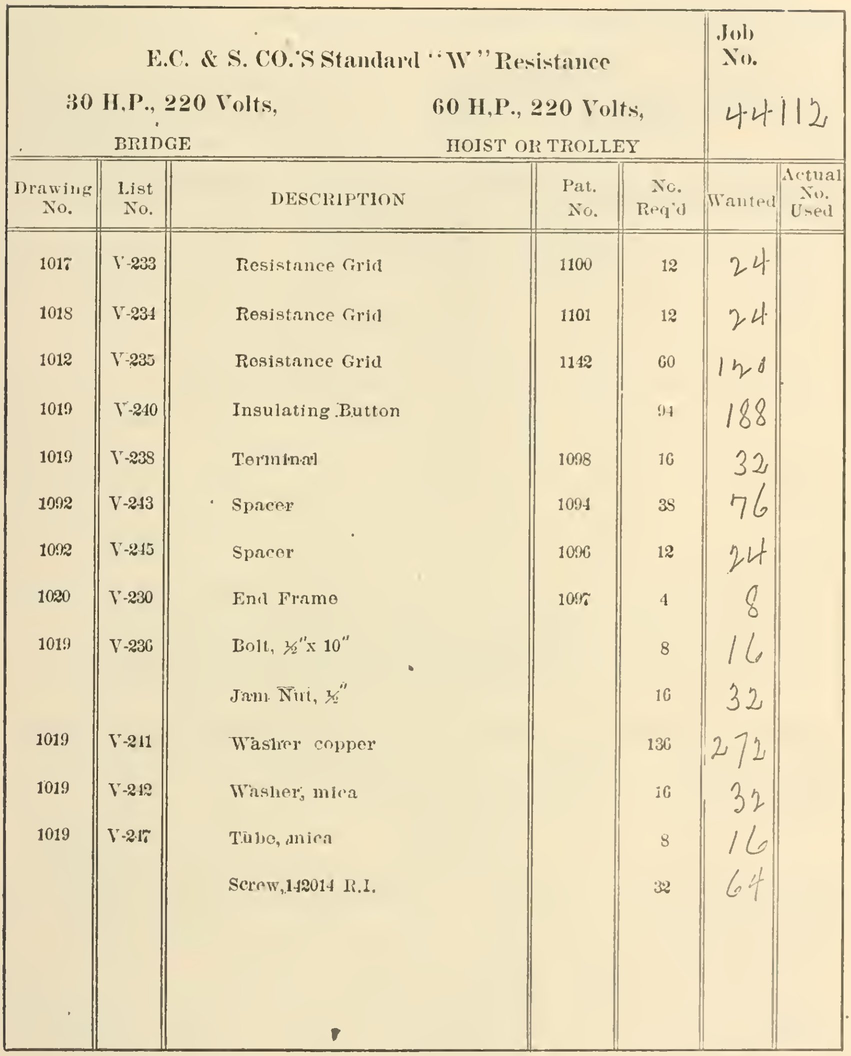
FORM F. FACE AND BACK. ATTACHED TO STOCK WHICH GOES TO TESTING ROOM.

The original is 10½ by 2¾ inches. The sections detached along the perforated lines and returned to the office by the tester and shipper are automatic notifications of the completion, test, and shipment of the apparatus. The stub end identifies the apparatus to the customer.



E.C. & S. CO.'S Standard "W" Resistance

30 H.P., 220 Volts, BRIDGE — 60 H.P., 220 Volts, HOIST OR TROLLEY

Job No. 44112

Drawing No.	List No.	DESCRIPTION	Pat. No.	No. Req'd	Wanted	Actual No. Used
1017	V-233	Resistance Grid	1100	12	24	
1018	V-234	Resistance Grid	1101	12	24	
1012	V-235	Resistance Grid	1142	60	120	
1019	V-240	Insulating Button		94	188	
1019	V-238	Terminal	1098	16	32	
1092	V-243	Spacer	1094	38	76	
1092	V-245	Spacer	1096	12	24	
1020	V-230	End Frame	1097	4	8	
1019	V-236	Bolt, ½"x 10"		8	16	
		Jam Nut, ½"		16	32	
1019	V-241	Washer copper		136	272	
1019	V-242	Washer, mica		16	32	
1019	V-247	Tube, mica		8	16	
		Screw, 142014 R.I.		32	64	

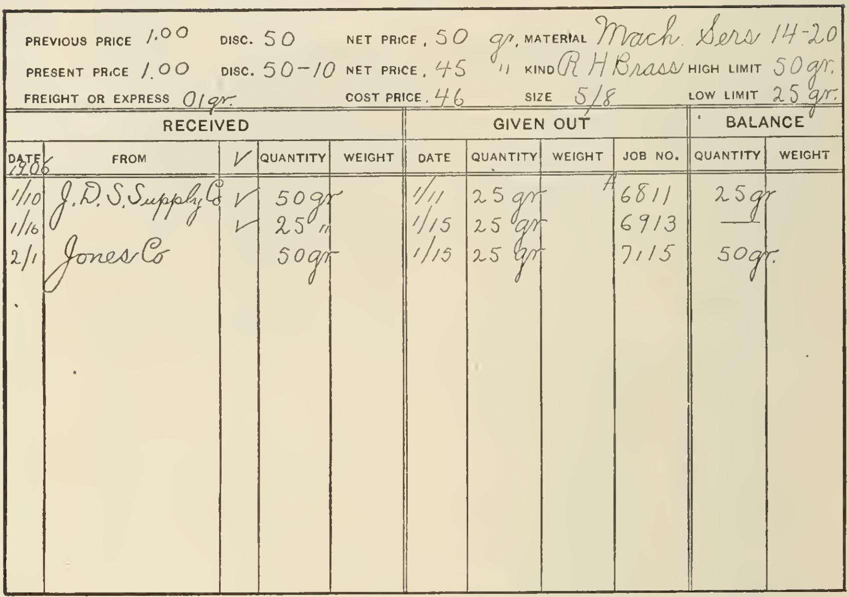
The Engineering Magazine

FORM G. USED FOR RESISTANCE PARTS OF CONTROLLERS.

Original is 4½ by 5½ inches. The printed list averts the danger of omission, where so many small items are involved.

way and much time is saved over the old way of issuing a card to the man and having him call for the stock as needed.

In addition to the above, all resistance banks and all apparatus which when complete will pass directly to the testing department and shipper, carry the tag Form F, the two end parts being returned to the shop office by the tester and shipper, thus automatically notifying the shop office of the completion, test, and shipment of the ap-



PREVIOUS PRICE 1.00 DISC. 50 NET PRICE .50 gr. MATERIAL Mach. Sers 14-20
PRESENT PRICE 1.00 DISC. 50-10 NET PRICE .45 " KIND R H Brass HIGH LIMIT 50 gr.
FREIGHT OR EXPRESS 01 gr. COST PRICE .46 SIZE 5/8 LOW LIMIT 25 gr.

RECEIVED					GIVEN OUT				BALANCE	
DATE ✓ 1906	FROM	✓	QUANTITY	WEIGHT	DATE	QUANTITY	WEIGHT	JOB NO.	QUANTITY	WEIGHT
1/10	J. D. S. Supply Co	✓	50 gr		1/11	25 gr		6811	25 gr	
1/16		✓	25 "		1/15	25 gr		6913	—	
2/1	Jones Co		50 gr		1/15	25 gr		7115	50 gr.	

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FORM I. RECORD OF RAW STOCK RECEIVED.

Original is 6 by 4 inches. Form shows standard order quantity and low limit, and carries all information necessary for inventory, pricing, and buying purposes.

paratus. The stub-end remains attached to the apparatus and enables the customer to identify it, as he has previously received a "Customer's" copy of our general office order.

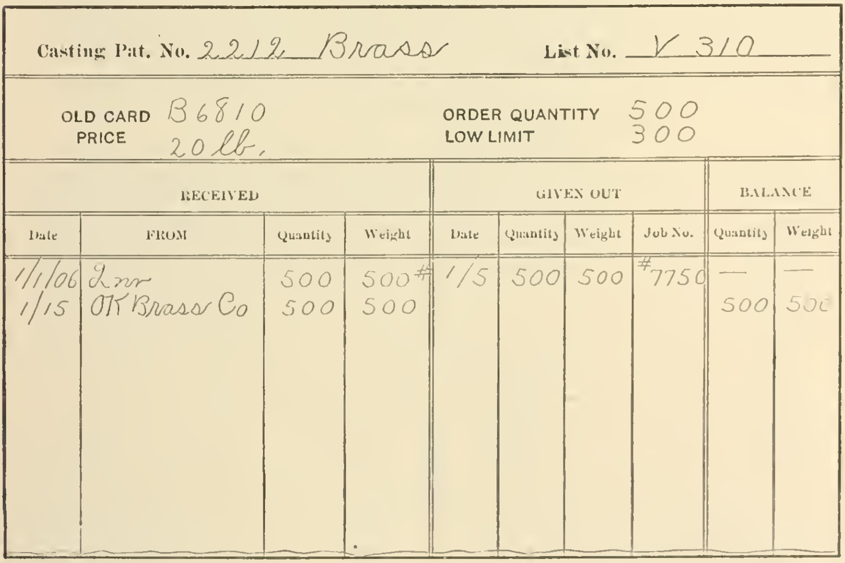
In the case of standard apparatus, quantity job-cards to manufacture complete (except parts which vary) are issued as needed, so that when an order comes in for a particular size it is necessary only to issue the stock for the variable parts and one of the tags, Form F. shown on the preceding page.

When the stock thus required consists of resistance parts for controllers, it is issued on the card Form G, which, being printed, prevents the mistakes and omissions that would often occur where so many small parts are used, and it also saves considerable time.

Receiving Stock.—Raw stock is counted, checked, and weighed by the receiving clerk, who O K's the dray bill; this is then handed to the clerks in charge of raw stock and castings, who copy it on Form H, a simple memorandum sheet which is not shown. It is then recorded on Forms I and J; these forms show, in addition to the disposition and condition of that item, all necessary information for inventory, pricing, and buying purposes. The prices are corrected every two months.

It will be noted that Forms I and J show the standard order quantity and the low limit, and it is the duty of the receiving clerk to keep a close watch on the balance column and to write a requisition for the standard order-quantity as soon as any item falls below the low limit.

Issuing Stock to Shop.—When the store keeper gets his stock list, Form D, with a job card, Form A, he frequently finds it necessary, especially in bar stock, to issue more than is necessary; hence, for each item he returns an account on a "Stock Memorandum," Form K, not shown, (being a simple memorandum slip of job number, stock, and quantity); this goes to the receiving clerk, who records it on Forms I or J, and all K-cards for one job are filed in an envelope bearing the job number, and ultimately the date of completion (Form M, not shown). Finished parts required are accounted for on a "Finished Stock Memorandum" slip, Form O, not shown, similar to Form K, but white instead of yellow, and also filed in M. All unused stock returned is accounted for on a blue "Credit Memorandum" slip, of the same shape as D and O and similarly ruled. (Form L, not shown) and filed in Form M. Borings and other scrap are also accounted for on this credit memorandum and the current value of such scrap is used in figuring the material cost of the job.



Casting Pat. No. 2212 Brass **List No.** V 310

OLD CARD B6810
PRICE 20 lb.

ORDER QUANTITY 500
LOW LIMIT 300

RECEIVED				GIVEN OUT				BALANCE	
Date	FROM	Quantity	Weight	Date	Quantity	Weight	Job No.	Quantity	Weight
1/1/06	Inv	500	500#	1/5	500	500	#7750	—	—
1/15	OK Brass Co	500	500					500	500

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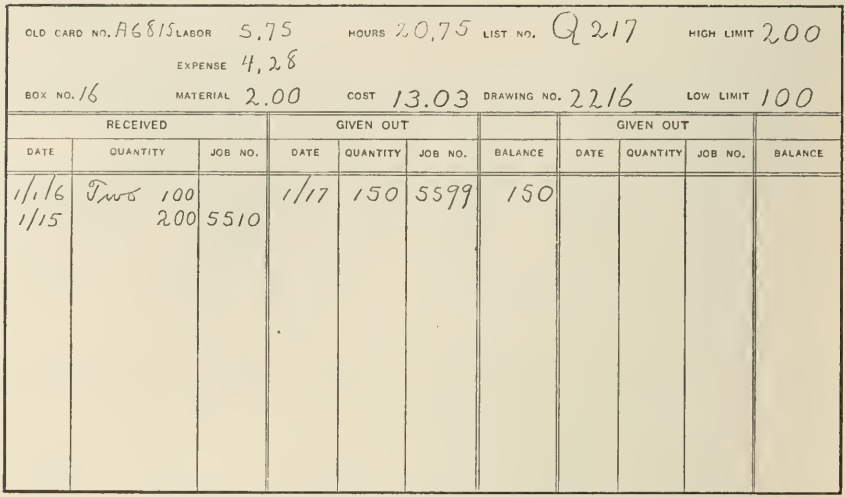
FORM J. STOCK CARD FOR RECORD OF ITEMS RECEIVED.

Original is 5 by 8 inches.



OLD CARD NO. A6815 LABOR 5.75 HOURS 20,75 LIST NO. Q 217 HIGH LIMIT 200
EXPENSE 4,28
BOX NO. 16 MATERIAL 2.00 COST 13.03 DRAWING NO. 2216 LOW LIMIT 100

RECEIVED			GIVEN OUT				GIVEN OUT			
DATE	QUANTITY	JOB NO.	DATE	QUANTITY	JOB NO.	BALANCE	DATE	QUANTITY	JOB NO.	BALANCE
1/1/6	Two 100		1/17	150	5599	150				
1/15	200	5510								

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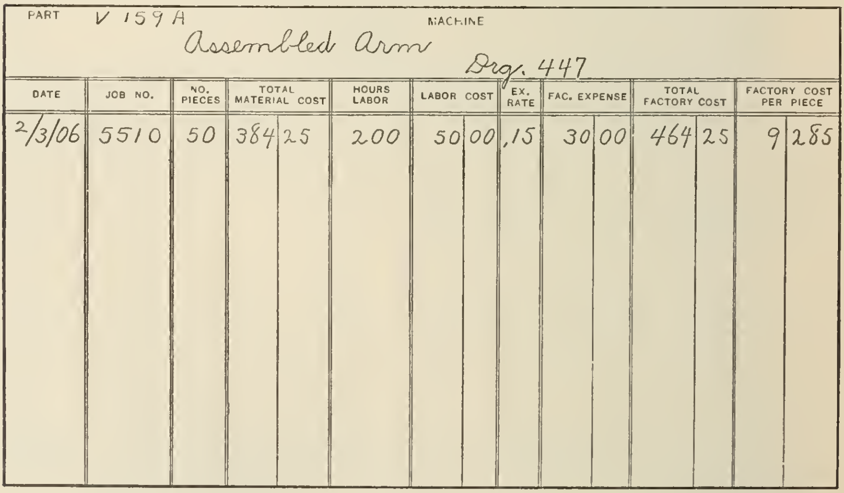
FORM P. RECORD OF FINISHED STOCK RECEIVED.
Original is 6 by 4 inches.

Stock so credited back is restored to stock cards, Form I or J.

When completed the job is received by the store keeper and accounted for on a pink " Finished Stock Received" slip, Form N, not shown, but again like K, L, and O, except as to color; it is then entered on Form P, which card it will be noted shows the cost properly divided, the location in the store room, and also a low limit and



PART V 159 A MACHINE
Assembled Arm
Drg. 447

DATE	JOB NO.	NO. PIECES	TOTAL MATERIAL COST		HOURS LABOR	LABOR COST		EX. RATE	FAC. EXPENSE		TOTAL FACTORY COST		FACTORY COST PER PIECE	
2/3/06	5510	50	384	25	200	50	00	,15	30	00	464	25	9	285

The Engineering Magazine

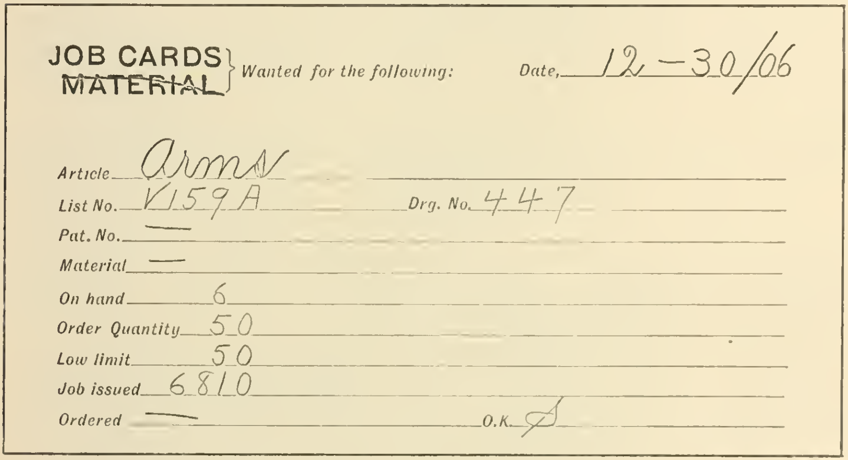
FORM Q. PERMANENT RECORD OF COSTS.
Original is 8 by 5 inches.

order quantity which is used in the same manner as described above for raw stock.

It will be evident that if the low limits and quantities have been properly proportioned, the quantity of stock on hand will remain at a practically constant level.

It frequently happens that when the requisition (R) for raw stock or for a job card to make up finished parts comes to the purchasing agent, he will have reason to lower or raise the order quantity and if he means the change to be permanent he will order it noted on the proper record cards.

When the job is completed, all the slips, Forms K, L, N, and O, are taken from Form M and used to check up and correct, if necessary, the list on Form C. The cost of the various parts, including labor cost and shop expense, are now extended; the cost of assembling is added, and permanent record is made on Form Q, which usually contains the record of the cost of former lots and hence affords instant comparison, which occasionally leads to the detection of error.



JOB CARDS
~~**MATERIAL**~~ } *Wanted for the following:* *Date,* 12-30/06

Article arms
List No. V159A *Drg. No.* 447
Pat. No. —
Material —
On hand 6
Order Quantity 50
Low limit 50
Job issued 6810
Ordered — *O.K.*

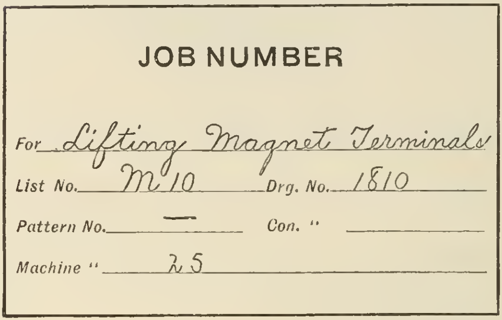
The Engineering M

FORM R. REQUISITION FOR STOCK OR FINISHED PARTS.

Form Q is filed for ready reference under the list-number of the part, and is frequently referred to for monthly and yearly averages. Duplicates of this form, showing the yearly average costs, are furnished to the sales department and to the estimating department.

Order Quantity and Low Limit.—When any piece of apparatus has been thoroughly developed and is ready to be added to our list of standard products, the sales department is asked to estimate the probable average monthly sales for the first year and with this as a basis the order quantities and low limits on all raw stock, finished parts, and assembled parts required, are determined at a conference between the purchasing agent, superintendent, and the superintendent of production.

The requisition, mentioned above, for stock or for finished parts, is special, as shown From R. It is evident that there has been an excessive drain on this item which will probably lead to a temporary or permanent raise in the order quantity.



JOB NUMBER

For *Lifting Magnet Terminals*

List No. *M 10* Drg. No. *1810*

Pattern No. *—* Con. "

Machine " *25*

The Engineering Magazine

FORM S. STORE KEEPER'S REQUISITION TO PURCHASING AGENT FOR LOW STOCK.

When job cards are issued for assembled parts which have fallen below the limit, finished parts and stock are issued and these in turn fall below the low limit and must be ordered, causing raw stock to fall below the limit and a new lot to be ordered. When all these operations are completed, we have in stock, for example, 50 assembled controller arms, finished parts for 50 arms, and enough castings and raw stock to make finished parts for 50 more arms. The scheme is designed to allow for the use of the assembled parts made last month on machines to be delivered in the current month; to assemble parts for use next month, machine parts for parts to be assembled next month, and to buy raw stock for parts to be machined next month.

The system requires considerably more outlay for stock than do hand-to-mouth methods, and therefore good judgment must be exercised in estimating probable sales and also in establishing the necessary limits from the basis thus given. It makes possible, however, a great increase in output per operative and per square foot of manufacturing space available. It also relieves the purchasing agent, superintendent, and all concerned of much unnecessary worry, and it makes it possible to live up to promised deliveries and thus materially aids the sales department.

For parts on which regular limits have not yet been set, the store keeper is expected to watch the stock and when low to requisition the purchasing agent on Form S.

Storage of Stock. This company moved into its present quarters in 1902. The space for office and shop was rented from the Wellman-Seaver-Morgan Co. Since then our output has more than trebled, and it has not been possible to expand the available space at the same rate. The W. S. M. Co. built a large office building and our general offices and drafting room secured space in it; later, we were compelled to put up a separate building for shipping and storage purposes, and finally we secured space to remove the tool room from the general shop floor, and still we find ourselves crowded to the limit and are compelled to make the best possible use of every available inch of space.

This company manufactures a number of types of controllers, brakes, lifting magnets, magnetic switches, magnetic solenoids, etc., and each type is built in several different frames to accommodate the various sizes of motors. All apparatus is necessarily subject to improvement; hence there are generally two and in some cases three styles of each type.

Controllers and magnetic switches especially involve the use of numerous small parts, and it is our practice to keep constantly in stock renewal and spare parts for all apparatus sold, even for apparatus whose sale has long been discontinued.

The storage of such parts, together with that of parts and raw stock for apparatus now manufactured, so that each is instantly available, involves a rather elaborate system of bins, drawers, racks, etc, and the first cut shown, Figure 1, hardly justifies my remark regarding instant availability.

That photograph, however, was taken about a year ago and since then we have learned how to make much better use of space, as I think Figures 2 and 3 will demonstrate.

In Figure 1, at the extreme left shows just the corner of a large case of small drawers for screws, nuts, small rivets, washers and similar small stock. The rack for reels of wire of all sizes is in the left background. Reels of wire can be taken from or replaced on this rack readily by means of the rope hoist attached to a small trolley carried along the top of the rack.

In the central background is shown a structural-iron rack for metal drawers of various sizes, generally used for small finished and assembled parts. There are four tiers of these boxes, each served by a traveling step-ladder which makes all this stock instantly available.

Each drawer is marked with a label, giving the list number, name, and the high and low limits for the piece. This latter precaution sometimes enables the store keeper to warn the stock clerks of a

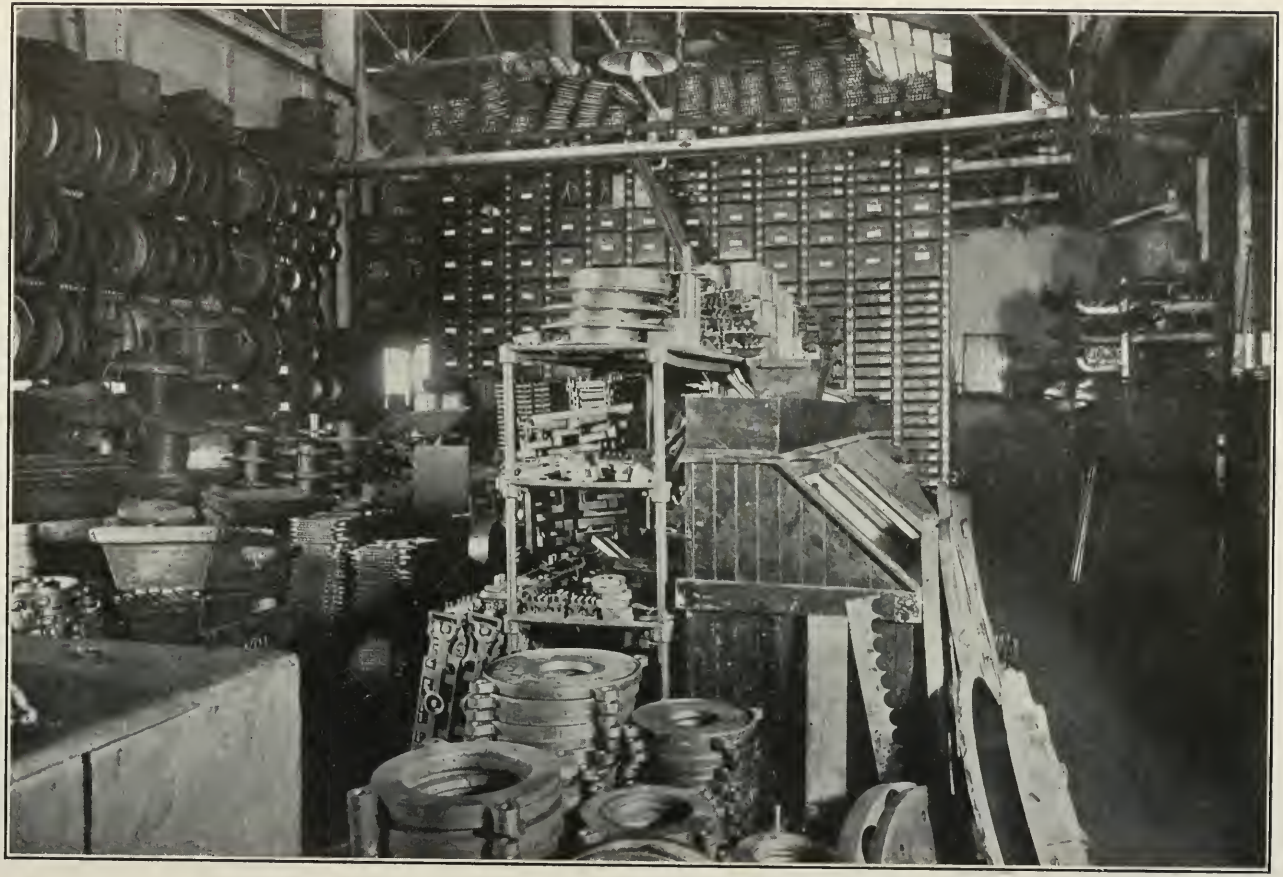


FIG. 1. GENERAL VIEW OF STORE ROOM. FORMER ARRANGEMENT.

At the left shows the corner of a case of small drawers for small parts; rack for reels of wire in left background. Structural-iron rack of drawers for small and assembled parts shows in central background. In the center, oil cabinet and rack for miscellaneous small articles.

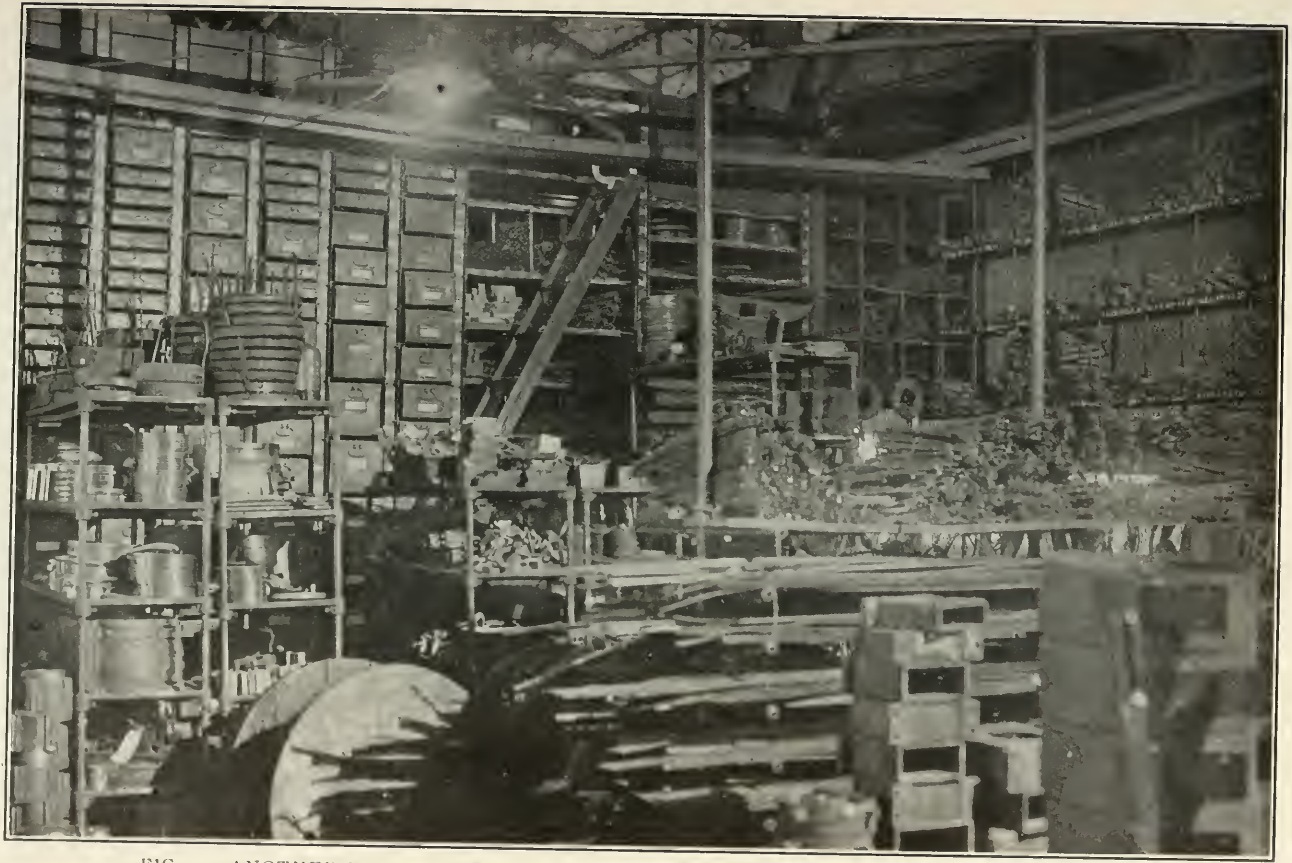


FIG. 2. ANOTHER VIEW OF THE STORE ROOM, WITH MODIFIED ARRANGEMENT OF SPACE.

In the left background, a second rack for metal drawers, arranged with large deep shelves at one end for sheet insulating stock. Racks for miscellaneous stock in center. Tree rack for bar stock in right foreground.

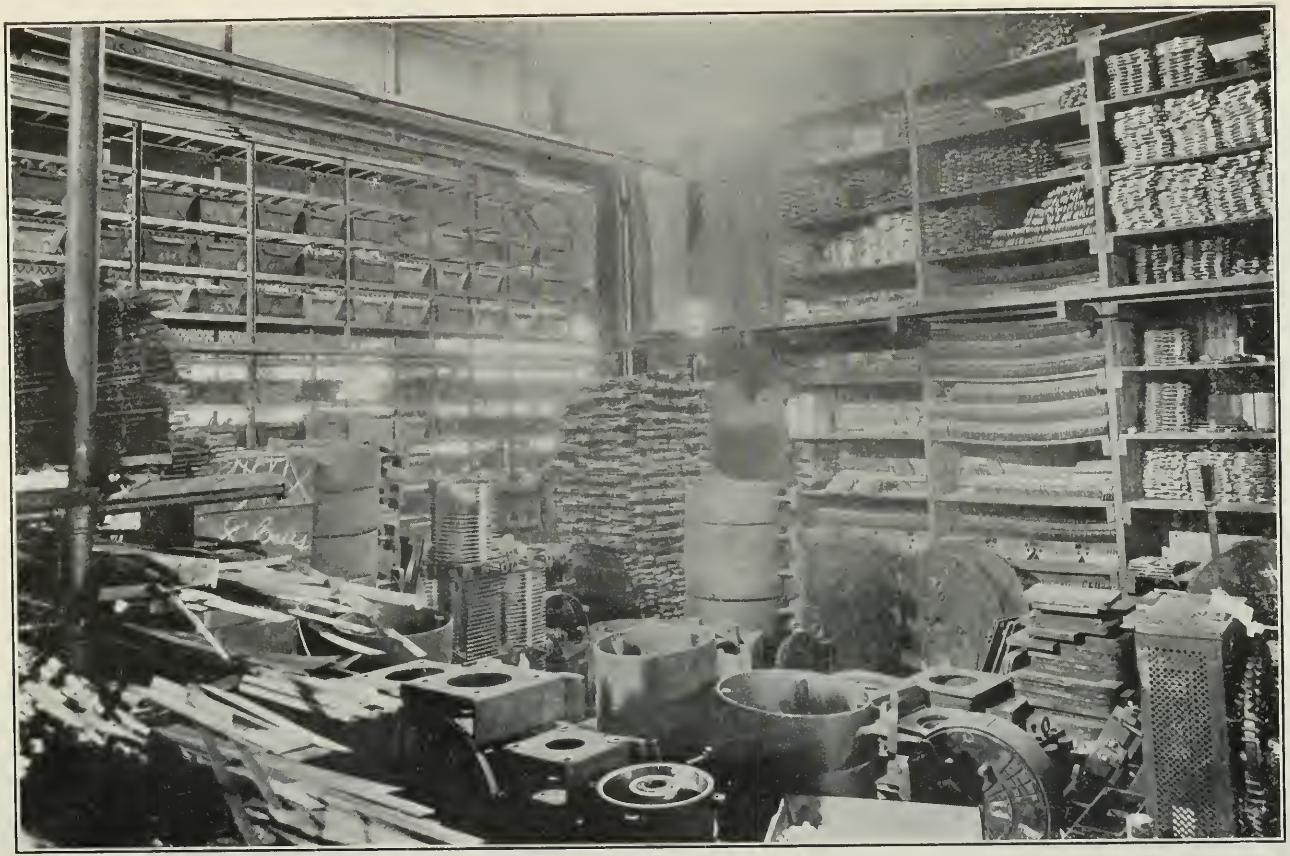


FIG. 3. A FURTHER VIEW OF THE STORE-ROOM ARRANGEMENTS.

The rack in the left background is designed for the shop stock pans described on the facing page and shown in detail on page 230. The bins on the right store about 20 tons of cast resistance grids, properly classified. Small castings piled in rows in the foreground are the heaviest stores carried.

shortage which they have overlooked, especially in parts not often used.

At the right of Figure 1 is the rack, consisting of long pigeon holes open at both ends, for Bar Stock. In the center is the oil cabinet and a rack made of cast-iron shelves for miscellaneous small articles, mostly for special jobs and therefore not carried in sufficient quantity to warrant assignment to a special space.

In the left background of Figure 2 is a second rack for metal drawers, arranged at one end with large deep shelves used principally for sheet insulating stock, such as fibre, asbestos, mica, hard rubber, fuller board, etc.

In the left foreground are more racks for miscellaneous stock.

The "E" coils 19 inches long for Dinkey ventilated controllers are stored in the rack at the right background, while under this rack, not visible, stands a wooden gridwork rack studded with about eighty long harness hooks and used for the storage of the small coils of special resistance wire.

In the right foreground is a tree rack for long flat stock.

The angle-iron rack for shop stock pans, shown in the left background of Figure 3, is part of a recently established system intended to reduce the amount of rehandling of parts to a minimum. The pans are made of sheet steel, measure about 12 by 20 inches at the top, and when full of small castings weigh about 150 pounds.

In the rack they rest on 1 inch by 1 inch angles, leg up, which fit the bottom loosely and thus permit of the pan being slid in or out easily. Just above the ordinary man's head is a walk reached by a step-ladder and used when handling stock in the upper rows. The heaviest stock is stored in the lower rows, the lightest in the upper rows.

This system, when complete, will consist of a number of these racks, each one carrying (small parts) stock, raw, finished, and assembled for a separate line of apparatus.

The set of bins at the right was designed to enable us to carry, properly classified as to sizes and styles, about twenty tons of cast resistance grids. The floor space occupied is twenty-four square feet which is easily less than one-fourth the space which would be required to carry such a stock, so classified, by piling the grids on the floor. There is a narrow walk, reached by a step-ladder, for handling the grids in the upper bins.

The small castings, piled in rows with aisles between, in the foreground of Figure 3, are the heaviest stock carried in the stock-room;

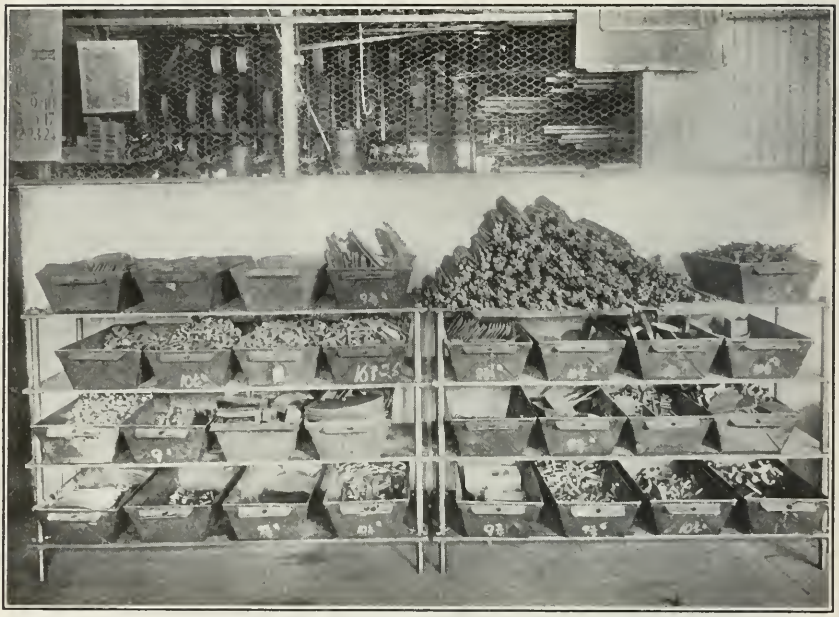


FIG. 4. RACKS WITH PANS FOR STOCK PARTS.
Carrying, in small space and conveniently assorted, all the pieces needed for the assembling of certain parts.

larger castings are delivered direct to the shop, a bad practice necessitated by our extremely limited storage space.

The pair of racks shown in Figure 4 are one of a number of such sets distributed about the shop. It will be noted that the pans are the same as those shown on the rack in Figure 3. This set of pans contains all the different parts required for the assembling of a certain part, yet very little floor space is occupied by it.

It will be noted that throughout I have seemed to consider economy of space as the chief desideratum; but, while that is absolutely essential in our factory, orderly and effective system is our chief aim.

The neat and orderly appearance of the racks, shown in Figure 4, undoubtedly has a beneficial effect on the workmen and hence on the output. A well-housed, well-groomed horse will invariably give better service than another equally as good and as well fed, but lacking the first two essentials.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker

V. THE RANGE OF ADAPTABILITY OF ALLOY-STEEL TOOLS.

Mr. Becker's discussion of this subject began in The Engineering Magazine for September, 1905, and extended in that series to a group of four articles, taking up successively the general outline of the problem, controlling principles in introducing the steel into the shop, working directions for the making of the tools, and the design and operation of tools and machines. In this supplementary series he will follow the present paper with two more; the next will deal with "The Tool at Work," and the following one thereafter with "Feeds and Speeds with the New Tool Steels."—THE EDITORS.

THE idea seems still to be rather widely prevalent that high-speed steel is adapted to but a small variety of uses—that its utility is chiefly confined to the heavy lathe and the removal of large quantities of metal by means of heavy cuts. The belief has been fostered, no doubt, by the widely spread reports of the performances and defects of the early and really experimental products put out by the pioneer manufacturers of these steels. There is no longer any reason for such a belief, for the new steels have been improved to such an extent, and the methods of treating them have been so perfected, that there is scarcely a use to which carbon steel is put in metal-working tools, where a high-speed tool will not do better work—provided, of course, the machine in which the tool is used is as well adapted to the latter as to the former. Obviously its greatest utility is in those processes where it is necessary to "slaughter stock," or in cutting material upon which an ordinary steel tool would be out of the question. There are, moreover, certain possibilities which have not heretofore been even thought of, as for instance, the machining of chilled gray iron, an operation now not only possible, but practicable and relatively economical.

Such operations, however, form but a small proportion of those performed in the average factory; and the real test of the utility of the new tool material is its economical applicability to the multitude of ordinary jobs for the doing of which carbon-steel tools have heretofore served very well. It is becoming more and more apparent that, even under the conditions involved in the use of machine tools designed to meet less strenuous requirements, high-speed tools must

CHIPS FROM LOCOMOTIVE TIRES, ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

The 12-inch rule gives the scale. The chips were turned in a 90-inch chucking lathe, two tools working with 5/16-inch feed and ½ to ¾-inch cut. An example of the work in which alloy-steel tools show their very highest efficiency.

eventually displace those of carbon steel, almost entirely. A certain evidence that the change is rapidly taking place is the greatly increased ratio of sales of high-speed tool material as compared with the ordinary carbon stock. So confident are some makers of alloy-steel in the general utility of their product, that they unqualifiedly guarantee to make tools to replace, at a saving, any carbon tool already in use. However much their confidence may be justified, it seems probable that within a few years at least eighty per cent of all jobs in machining iron or steel will be performed by high-speed-steel tools. Such a condition can come about only in consequence of a demonstrated superiority in quality or greater economy of output—a demonstration now well in process.

In many plants the change will of course be slow after those jobs have been taken care of in which the use of the new steel is so plainly indicated as to be practically unavoidable. Indeed, there are cases where the management of a plant is so short-sighted as actually to discourage further use of high-speed tools. Competition will undoubtedly in time compel a larger use of these tools, even in such cases; and as existing equipment wears out and is replaced with heavier, capable of using them to something like their full capacity, their greater efficiency will become so obvious that it cannot be longer ignored.

Four considerations affect the efficiency of a tool: first cost, accuracy of work, cost of maintenance in an efficient state, and endurance. Many a tool user regards only the first, whereas it is not necessarily even the most important consideration. Frequently it is the least important. The total cost of all the items properly chargeable to the tool itself, per piece satisfactorily finished, is the only rational basis for making such a comparison. And considered on such a basis, the greater efficiency of the high-speed tool becomes manifest under practically all conditions and on nearly all jobs.

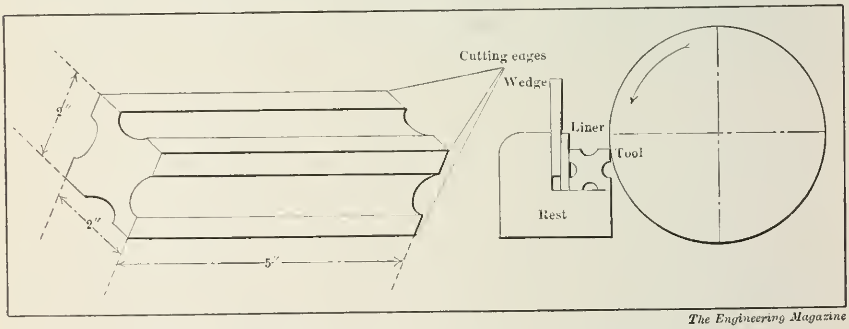
In the lathe, whether of the chucking or turret type, scarcely a job can be mentioned that is not done as well, at the least, as with a carbon tool, and at a considerable saving in the time required for grinding and setting up, even if there be no increase in cutting speed or amount of metal removed. Just how this occurs has already been pointed out and need not be here repeated. The objection formerly made that high-speed-steel tools were not suited to finishing cuts does not now hold. The grain of some brands, if not of all, is as close and the cut as smooth as could be desired. This being the case and the tool holder and the correspondingly inexpensive small-piece tool, (requiring practically no forging and needing little more than to be cut off and hardened) being available at ordinary speeds and cuts such as are taken with carbon-steel tools, the first cost of the tool becomes insignificant, and the saving in grinding and setting-up time is clear again—often no inconsiderable item, either.

For illustration, take the following data, which may be duplicated in the essential features in almost any lathe job that might be mentioned:

Tool	Pcs. Finished per grinding.	Time for Grind. etc.	Total Pcs. Finished.	First Cost of Tool.	Cost of Time, per Hr.
Carbon	50	5 min.	1,000	$0.25	$0.20
High Speed	300	5 min.	10,000	0.75	0.20

The time lost in grinding and setting up figures out as costing 3.3 and .55 cents per hundred pieces for carbon and high-speed tool respectively; and in the same manner the first cost of tool comes out as 2.5 and .75 cents respectively per hundred pieces. Whence the total cost of tool and tool maintenance, per hundred pieces finished, is for the carbon-steel tool 5.8 cents and for the high-speed tool only 1.3 cents. And all this without any change whatever in the speed or cut, the whole gain being the result of the greater endurance of the high-speed tool.

There is a growing disposition to use chilled rather than sand-molded castings for many purposes. The practical impossibility of machining such castings has heretofore prevented an extension of their use. Chilled rolls have indeed been turned with the very best of tools and at an extremely slow rate; but further than this little has been possible heretofore. With high-speed tools of proper form it is comparatively easy to machine rolls to a plane surface, and even to cut grooves and spirals. For this kind of work, however, the ordinary pointed tool will not do, and it is necessary to use a special form of cutter. The most satisfactory results are obtained with a tool having a long cutting face and an edge approximately of right-angle section. For the support of such a tool ordinary methods are, of course, not available, since it is impossible to obtain sufficient rigidity.



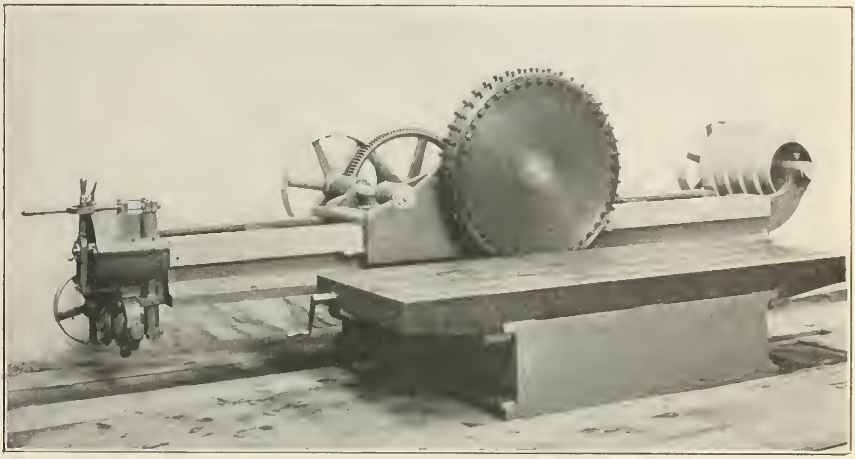
The Engineering Magazine

TOOL FOR CHILLED-ROLL TURNING, AND METHOD OF TURNING EMPLOYED.

The grooves in the tool reduce the amount of grinding necessary to renew the cutting edges. An ordinary tool rest is of no use; the tool is supported on a suitable rest bar and wedged (or screwed) against the roll. There is no forward feed.

A satisfactory method is to use a square bar of suitable length, say four or five inches, and one and one-half to two inches section, with grooves milled or planed into each side. This is ground so that the long edges are true and sharp, and properly hardened. The cut is taken by one of the long edges, the tool being held against the face of the roll by a special rest bar, the cutting edge slightly below the level of the axis of rotation. This tool is not fed along the face of the roll by the lead screw, but is pushed against it by screws or wedges, preferably the latter, until the required diameter is obtained. It is then moved and another section turned in the same manner. If care is taken it is not necessary to remove the tool for cooling, and it will stand a good deal of cutting without re-grinding.

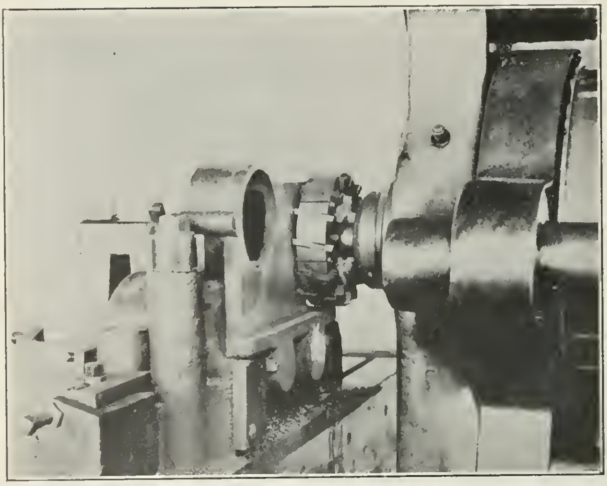
For grooving, the tool is ground at the end to just the form of the required groove and pushed against the roll in about the same way as in surfacing. The ordinary tool holder is quite useless, and the cutter is wedged into an arched holder and forced against the roll by wedges and screws, preferably the former.



A ROTARY PLANER. INSERTED ALLOY-STEEL CUTTERS.
A recent type of machine tool combining high efficiency with relatively low tool cost.
Wm. Sellers & Co., Phila.

The inherent weakness of all reciprocating machines is in the fact that they *do* reciprocate. The consequent loss of motion in stopping and starting again at the end of each stroke makes them relatively of greatly inferior inefficiency compared with machines working upon the rotary principle. It has been thought heretofore that the cutting speed of such machines as planers, shapers, and slotters could not be increased very considerably because of the jarring at each reversal—a belief pretty well founded in so far as it concerns machines of these types other than those of most recent design. Little thought has therefore been given to the question of applying high-speed tools to them.

Of late, however, there have been some developments in this class of machines going to show that the high-speed tool is to have a larger place as a reciprocating cutter. Even if there were no important in-

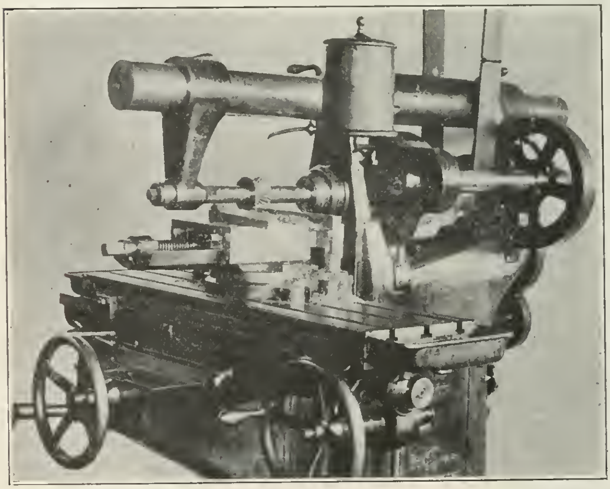


AN 8-INCH INSERTED-TOOTH MILLING CUTTER AT WORK.

Facing off change-feed box, table feed of about 7 in. per minute. Becker-Brainard Milling Machine Co.

crease in the speed and power of such machines, the same reasons which make a high-speed tool desirable in a lathe even under ordinary conditions, apply to the planer and shaper tool, though possibly to a less extent. That is, the time saved in grinding is relatively of less consequence, because there is not a great deal of grinding to do anyway. The saving in cost of tool per piece machined, the only correct way of reckoning tool cost, however, corresponds to that shown in the case of lathe tools.

But the new rapid-stroke quick-return machines make it possible to increase considerably the speeds, and in most instances the feeds also; and thus require, in order to reach their highest efficiency, the high-speed tool. A recent demonstration showed

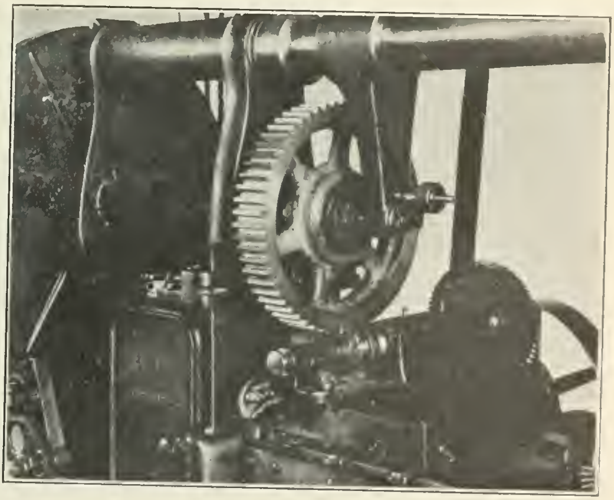


ONE PAIR ALLOY-STEEL 40-DEGREE ANGLE CUTTERS BEVELING TOOL-STEEL GEAR-CUTTER DOGS.

Table feed ¾ inch per minute. Becker-Brainard Milling Machine Co.

that it was entirely practical to plane steel forgings * in a 36-inch machine and under unusually difficult conditions, at the rate of 40 feet per minute, feed ¼ by ½ inch; and gray iron plates 12 by 23 inches have been regularly roughed in six minutes and smoothed in half that time. A 24-inch planer of the same design has been run at a speed and efficiency that has made it possible to reduce the labor cost on the job for which it is particularly used, from 30 to 8 cents per piece, increasing the former output of 9 to 12 per day to 40 to 55. A quadrupled efficiency is not to be expected in all cases; perhaps not even in many. But even so, a much less striking increase in efficiency would amply justify a change. A reduction of 50 per cent in planing time, as guaranteed by one maker, is certainly worth considering.

The evident tendency of the milling machine to replace the planer, shaper and slotter has been accentuated by the new tool steels, whose efficiency is not subject to the same limitations in the form of a rotating tool as in the reciprocating form. All that has been said of pointed tools, with respect to their superior efficiency when of high-speed steel, holds true, to a greater extent, even, of milling cutters. The grinding of most such cutters, however, is of necessity carried on in the tool room where it may be done with the required degree of accuracy, and is therefore more expensive than in the case of the simpler tools. The most important gain, however, is in the greatly increased feed allowable when high-speed tools are used. It is true that an increase in speed is also possible; and while advantage is taken of this circumstance, the best practice now indicates increased feed rather than greater cutting speed so far as



A 36-INCH AUTOMATIC GEAR CUTTER CUTTING CAST-IRON SPUR GEAR.

Time about 2 hours, completing the whole gear. Becker-Brainard Milling Machine Co.

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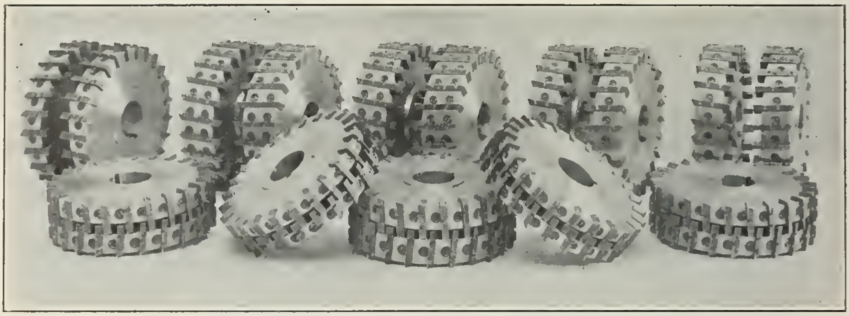
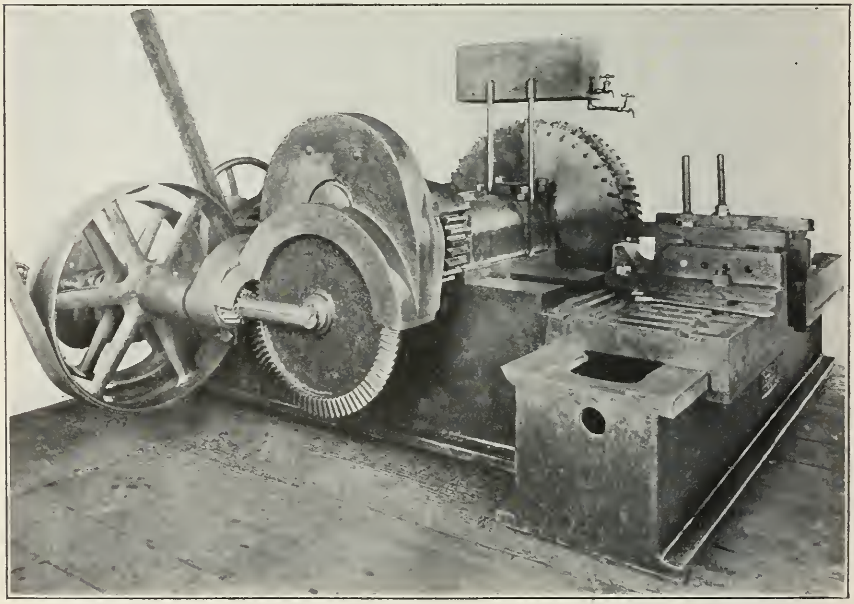
* Test of their new design of planers, at the works of the Chandler Planer Company, Ayer, Mass.



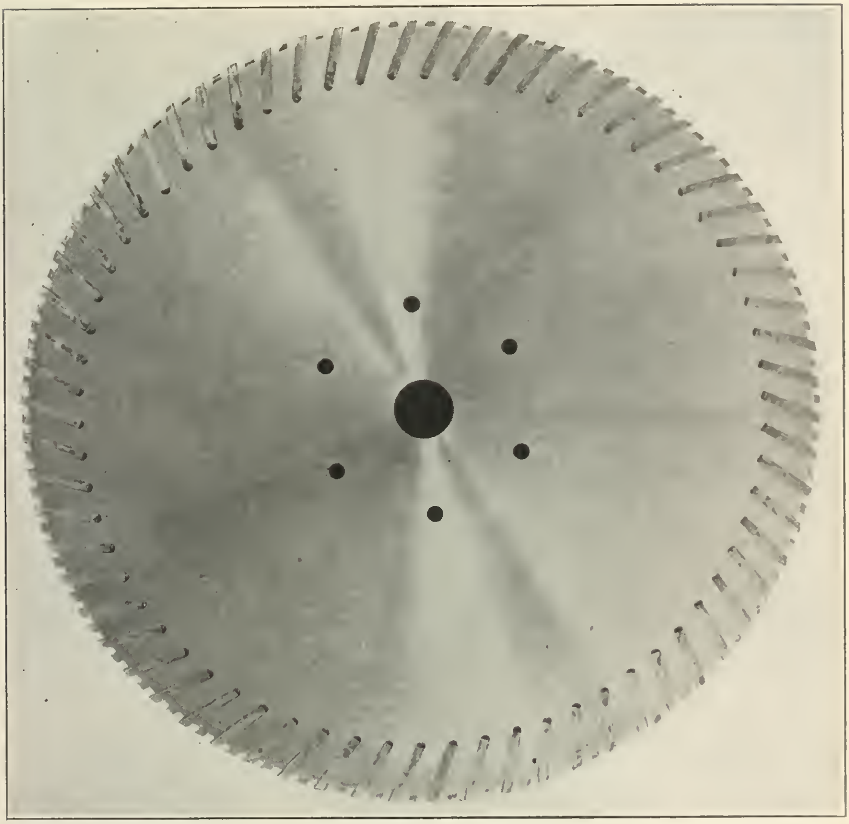
A GROUP OF INSERTED-TOOTH CUTTERS.
Brown & Sharpe Mfg. Co.

milling operations are concerned, whether it be upon castings, forgings, or other materials. On this account it is in most cases advisable that the clearance of the cutting teeth also be increased by the use of fewer of them.

The design of these tools has already been considered, and it is unnecessary here to elaborate the former discussion. It may, however, be pointed out that for millers of relatively narrow cut-



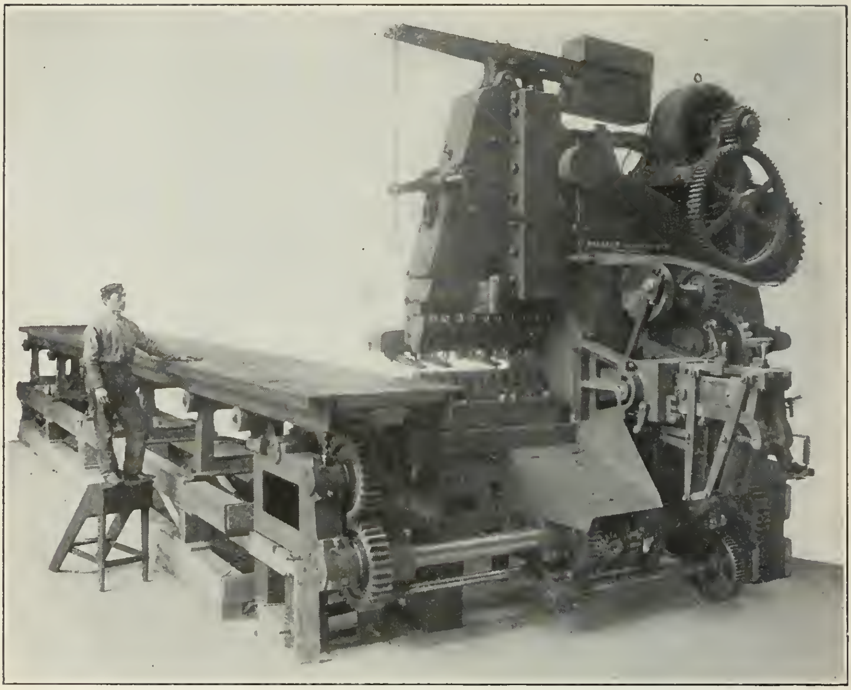
DOUBLE ROTARY SLOTTING MACHINE, WITH INSERTED ALLOY-STEEL CUTTERS.
High-Duty Saw & Tool Co., Eddystone, Pa



HIGH-DUTY INSERTED-TOOTH TINDEL SAW, FOR CUTTING STRUCTURAL STEEL SECTIONS AND RAILS.

ting face, inserted teeth allow the production of a comparatively inexpensive tool for all diameters over four inches. For smaller diameters it is necessary to use the solid tool, which somewhat increases the tool cost per piece.

A typical case showing the superior efficiency of high-speed milling cutters is here given. On gray-iron castings a 3½-inch cutter (18 spiral teeth) cuts at a surface speed of 82 feet per minute with a table travel of 27 inches per minute, and mills 6,800 linear inches at a grinding. The best results obtained with a carbon-steel cutter under the same conditions were 1,300 inches at a table feed of only 15 inches per minute. The carbon tool requires grinding once a day, at least, whereas the high-speed cutter runs five days, the former finishing rather less than 270 pieces per grinding, to the latter's 1,360 pieces. It was possible to reduce the labor cost per hundred from



A SUGGESTION OF ECONOMY IN USING ALLOY-STEEL PUNCHES.
Stopping a large gang punch to replace a broken or worn punch means a loss of time that might easily pay for the high-speed tool. The more the punches in the gang, the greater the proportionate loss of time. The large machine here shown is by Wm. Sellers & Co.

$1.40 to $1.10. Besides this there is the saving in the expense of grinding to the amount of $0.11 per hundred pieces, so that the entire saving is $0.41 per hundred pieces—enough to pay for the additional first cost of the tool in less than a week. Furthermore, the tool has an almost indefinite life, outlasting from five to twenty carbon tools, so that if considered merely with reference to the first cost and amount of work done, the high-speed cutter is from one-third to one-tenth as expensive as the carbon tool.

High-speed drills are undoubtedly as efficient on every class of work as are the other forms of cutters already considered, unless possibly in the smaller sizes. It may be questioned if there is any particular advantage over a carbon-steel drill in any size below quarter inch. There is not enough metal in the sizes smaller than this to stand the rough usage which may be freely given larger drills, and with speeds and feeds much increased there is likely to be considerable breakage of drills. It is, nevertheless, true that striking results have been obtained from small-size drills, and they are made for sale down to ⅛-inch. Slightly annealed, so as to increase the toughness, a small drill rarely breaks, if used with reasonable care; and though it does not hold its edge as well as if harder, it invariably greatly outlasts a carbon drill. A ¼-inch drill has been run continuously at a rate of about 1,100 revolutions per minute with a feed of .008 per revolution, in ordinary mild steel, without breaking down; and in gray iron somewhat faster. The agreed rate for a carbon drill under similar conditions is about 220 revolutions per minute with a feed of about .005 per revolution. Stated in terms of peripheral speed the ratio is 826 to 176. The same ratio (about 4.5 to 1) holds good throughout the various sizes, whether large or small; and when it is remembered that the feed allowable is practically double that of the carbon drill, it is seen that the amount of metal removed in a given time is in the ratio of 10 to 1, approximately. This looks big, very big; but in practice the labor rate is largely dependent upon the time lost in handling the piece and in keeping the tool in a state of efficiency; so that in operations involving the boring of shallow holes, where the working time of the tool is short compared with that required for changing the piece, the chief gain is in the time saved in taking care of the tool and in its greater life. When, however, holes are of any considerable depth, so that the cutting time becomes the chief factor, the saving is likely to amount to considerable.

Multiple-lipped drills, rose-reamers, and similar boring tools are in the same category as the double-lipped twist drills, in this respect. There is, however, at least one consideration which differentiates them. The latter, employed mainly in enlarging and truing holes already existing, take a thin chip, with the peripheral part of the lip only, so that the tendency is to wear the outer angle of the tool and reduce the size—a process that proceeds in an increasing ratio when once started, and necessitates careful watch in order that the tool may be kept well ground and in size. The advantage of a tool that will hold its cutting edge for a long time under such circumstances is apparent. In the larger sizes of rose reamers, which take considerable time for grinding, the advantage is still greater. In these sizes, too, say those above a 2-inch diameter, the first cost need not be greatly in excess of that of a less efficient tool, because the inserted-cutter tool may be used. As has been previously pointed out, in case a reamer whose cutting blades are held by mechanical means rather than by brazing can be used, and the cost of the holder distributed over several sets of cutters, the first cost of the tool becomes actually less than that of an ordinary carbon tool.

The discussion of reamers and drills reminds one of the stock joke of the man who bought a high-speed bit to use in a ratchet drill, and complained of his results. The joke has lost its point, for mechanics are getting into the habit of buying high-speed drills, taper reamers, and other tools of similar kind, for their kits, finding that it pays to use them in preference to the old kind. So also with hand reamers, especially when used for accurate sizing. Their life is limited to the time they retain their accuracy. What profits it, therefore, to use a carbon tool at half the cost, when the life of a high-speed tool is ten times as great?

The same considerations which affect small drills likewise affect small taps and thread-cutting dies. If left hard enough to get the highest efficiency, the small cutting edges are too brittle to stand up, and easily crumble away. Proper annealing, however, entirely obviates this difficulty, though of course the cutting speed and the life of a grinding are somewhat reduced. Taps as small as 5/16-inch have been used under these conditions at an efficiency eleven times that of the highest previously attained; and in practically all cases the same ratio of increased efficiency is developed as in other classes of cutting tools. Thus, to give another typical illustration, a high-speed die regularly threads 1-inch bolts at the rate of about 20,000 per grinding, against 7,000 under former conditions—a saving that in a short time more than covers the original cost of the tool.

It is perhaps unnecessary to consider at length that variety of other cutting tools which includes hollow mills, boring-machine tools, and the like. They are for the most part comparable in their action and efficiency with lathe and planer tools, and are affected by about the same considerations as the latter. There is, however, one other form of cutting tool that deserves notice, namely, the cutting-off saw. Between the hack-saw blade of old and the best cutting-off saw made previous to the application of high-speed steel there is a difference, to be sure. But all these have been lamentably inefficient. The high-speed cutter, as now made, permits a bar of metal to be cut off, not as if it were wood, of course, but at a rate that is somewhat in keeping with modern expedition. Thus far, little use has been made of thin-bladed saws for high-speed cutting, ordinary milling cutters of three-sixteenth or one-quarter-inch thickness being mostly used. Even these have been unobtainable in diameters above 9 inches, and their usefulness has therefore been rather limited.

Plates as thin as ⅛ inch and in larger diameters are now available, and will, no doubt, completely displace carbon circular saws for metal cutting.

The inserted cutter idea is peculiarly applicable to metal saws of large diameter, such as are coming into use for slotting. For this purpose a new type of machine tool is being developed which bids fair to find an important place in the metal-working industries. A recent machine of this type operates two saws of 73 inches in diameter, cutting 1 5-16-inch slots.

There has apparently been so little experience in the use of the alloy steels for the blades of cutting-off shears and similar tools that little can as yet be said in reference to the economy of their use as compared with carbon blades. It is scarcely necessary to repeat what has been already said and what is also quite obvious—namely, that any economy effected by such tools is almost entirely the result of their longer life and the lessened need for grinding. In the case of punches the difference is very well marked, as well with respect to those used for punching holes as those used in blanking forms.

The ordinary punch, as is well known, usually gives out by collapsing or breaking off after the edge has become somewhat dulled. The increasing force required to drive the punch through the metal rapidly increases the molecular fatigue or intensifies already existing internal strains until the endurance limit is reached. The limit in high-speed steel is not very well established, but is certainly much beyond that of carbon steel of the best kind. Objection has been made to high-speed punches that, like drills, they are too brittle. The same answer however applies, namely, that proper annealing, to give the requisite toughness, obviates the danger of breakage, or reduces it to a minimum. Small-size punches, however, if working through thick, high-carbon steel, are difficult to temper to just the point at which they will have the required hardness and at the same time be tough enough to stand up. For this kind of work, where the holes are under, say ½-inch, the results with carbon punches seem to be about as satisfactory as can be obtained with high-speed tools, unless the stock is relatively thin. But in all the larger sizes, and in the case of tools for broaching holes in malleable iron, there can be no mistaking the higher efficiency of high-speed punches. A ⅞-inch punch, for instance, punches about 56,000 holes in a ⅜-inch channel iron. The life of a carbon steel punch is about 6,000 holes. This is in the ratio, approximately, of nine to one, a ratio which holds good for nearly all punching operations except as already pointed out.

In the case of blanking dies the question is not one of breakage, but of holding a clean and sharp shearing edge. Such a die made of high-speed steel, or faced with it, will do this almost indefinitely. For the blanking of large forms there is no necessity for using the high-priced material for backing; it is sufficient that the cutting faces be of high-speed steel, and solidly brazed to the backing, which latter may be of machinery steel if desired. The expense of making such a tool is little greater than if it were of the ordinary type—often it is considerably less. It of course depends upon the form of the die and the work it is to do.

The displacement of small castings by formed steel pieces has been growing apace since the advent of low-carbon sheet steels working easily in the forming die; and the press-working of sheet metals has come to be a distinct and important branch of metal working. The dies for operations of this sort are generally expensive because they must be accurate within very narrow limits. In making all but the simplest forms, the wear on some parts of the dies is very great, and they soon become worthless because they are no longer accurate enough for the work required. Hardening the faces of such dies has been resorted to with some success. But even the hardest carbon-steel forming blocks have a comparatively short life. A high-speed steel die, of course, costs a great deal more, especially if large, than the other. Its life, however, is so much longer that it much more than compensates for the greater first cost. It is to be remembered that in all such dies the prinicpal item in their cost is not material, but labor; and only in exceptional instances is material cost of relative importance.

Even this additional cost may be avoided in part by the use of inlays of high-speed steel, brazed to the face of the die, in such places as are particularly subject to wear. Such dies last about as well as the solid ones.

Even in the forge shop high-speed steel is coming to claim an important place. Much that has been said of sheet-metal forming dies applies to drop dies also; and it is found cheaper to pay more in first cost of die material than to pay for the renewals of the tool that would be required. In the heading machine especially is the high-speed die desirable. The excessive wear upon such dies, and in the case of hot pressing, the liability to drawing the temper and still further reducing the life, suggests the advisability of discarding entirely the carbon dies in favor of the high-speed ones. The one exception seems to be that of the cold heading die where the pressure required is so great as to split the block when made of alloy steel. This happens commonly when heading particularly tough stock; and though quickly worn out, the carbon-steel die does not usually split as readily as the harder high-speed one.

In all cases, however, where tremendous pressures are unnecessary, the latter is greatly to be preferred. Take wire drawing, and other cold-drawing dies, for example. One of the chief difficulties always has been to maintain a uniformity in the size of the drawn rod or wire. If the exactness of size is important and the material exceptionally hard, the question becomes a very serious one. The answer is, high-speed steel for such dies. The life of the latter has been in some cases thirty times that of the best carbon-steel dies. The same is true of snap dies used for riveting. It remains to be demonstrated, however, that high-speed steel is superior to the best chisel steel for snaps and cutters in rapid-blow pneumatic tools.

Is it recommended, then, that alloy steel be used for all sorts of jobs and all classes of operations upon metals? Yes, practically all. As has been frequently pointed out in the preceding pages, in most jobs aside from those involving the paring principle, there is little, if any, increase in speed to be looked for. The gain is found mostly in the greater life of the tool and the reduced cost of maintenance. And though there may be no reduction in the labor cost of a particular product, the saving in the tool room alone is sufficient to justify the change. Any such saving, however—and, indeed, any considerable saving in the use of high-speed-steel tools in any operation—is predicated upon properly made tools. Many a manager or foreman has been unable to discover any advantage in the use of such a tool merely because it had been improperly made by men unskilled in the manipulation of the alloy steels. Common sense would indicate the need of careful attention to this point, for it is usually more important in determining the efficiency of a tool than any other single element.

In the discussion thus far, it has been assumed that high-speed steel is adapted to metal-working tools only. This is the general impression, and it may surprise many to be told that the new steels are finding favor as materials for wood-cutting tools. So far as is now known to me there has been no general disposition to make use of them for this purpose. Experience has shown, however, that high-speed cutters working on wood have in many cases a distinct advantage over ordinary cutters. A certain manufacturer of wood planers has taken advantage of this fact to market his machines equipped with high-speed cutters, which he advertises as of a special steel not obtainable from the makers of other machines of the kind—an advertisement quite true unless other makers of wood-working machinery have also discovered the utility of the alloy steels and now make use of it for the same purpose. However that may be, it is certain that some managers of wood-working plants are finding out that high-speed steel is a good thing for them, and are making increasing use of it. Not only are planer knives, but forming knives, back knives, and, in fact, all sorts of cutters made of alloy steel. Even circular saws are used by certain enthusiastic discoverers in this new field opened to these wonderful steels.

An example of what is possible in wood working with alloy-steel tools will no doubt be of interest. In a certain job, cutting dowels from hard maple sticks, the ordinary cutter could not be made to work longer than half an hour at one honing; and even then, it was necessary to set it up several times in order to get the dowels properly sized. A cutter of high-speed steel easily runs thirty hours, and at the end of that time is in such good state that it would doubtless run as much longer without needing to be set up to preserve the required degree of accuracy. This is an efficiency of at least sixty to one, as compared with the old knife, and is typical of wood-cutting jobs in general.

It is, perhaps, too early to make any general predictions as to the extent to which the new steels will be found suited to this kind of work. But it is quite certain that for cutting hard woods at any rate, the field is wide open with all experience favorable to an extensive use. And while as yet these steels have had no large part in the wood-working industries, it is not beyond the possibilities that they will before very long practically displace carbon-steel here as they are doing in the metal industries.

MECHANICAL REFRIGERATION AND ITS FUTURE DEVELOPMENT.

By Joseph H. Hart, Ph.D.

Dr. Hart uses the interesting method of analogy in studying the refrigerating machine by the light of our fuller and wider knowledge of the steam engine. Each, he points out, is the converse of the other; therefore the principles established in the older field may profitably be extended for our guidance in the cultivation of the newer one. He makes it clear that this idea has a very practical bearing on the future of the refrigerating industry. —THE EDITORS.

MANY an engineer, at some time or other, observing the steam engine and ammonia compressor at work side by side in a refrigerating plant, has permitted his imagination to wander into more or less indefinite speculations on the analogy between the two, and the almost self-evident reversibility of action of one of the machines in comparison with the other. The extent and quality of such speculation will depend largely on the training and knowledge of the observer; to a steam specialist or a compressor designer, the analogy would be much clearer and extend further, but it could only appear complete to the specialist in engineering physics.

Such an analogy (or rather antithesis) in the action of the steam engine and compressor not only exists, and is of great interest, but a comparison of the entire heat theory with corresponding refrigeration conditions shows an almost perfect analogue, and a study of this promotes a much clearer understanding of both steam and refrigeration plants. It also serves the further purpose, that in pointing out the difficulties and errors and the line of true development in the production of heat and power, one can, by analogy, invariably arrive at the solution of corresponding problems in the theory of refrigeration. In addition, advances in the first-mentioned field are almost immediately followed by a similar development in the other; and today we have a number of improvements in heat processes which must sooner or later find their way into refrigeration. Under the circumstances, a close and systematic study of this analogy cannot fail to be of the greatest interest and conducive of good results, if only in pointing out the lines of least resistance for future development in experimental work in refrigeration.

The analogy extends throughout the whole range in the theory of heat. The generally accepted view in regard to the nature of heat is that it is the kinetic energy of the molecules. When a body gets hotter it is believed that the chief change is simply an increase in the average kinetic energy of these molecules; when a body gets colder— that is, when refrigeration occurs, either naturally or artificially—the molecules lose naturally or are deprived of their kinetic energy and the average energy becomes lower. This explains the connection between heat and work, and shows that when a body does work, the energy is taken from this source and the body gets colder; and also that by doing work on a body, the quantity of heat in it may be materially increased from this source of energy, as is evidenced by its rise in temperature. This phase of the theory is the working principle back of many steam engines and of the Bell-Coleman and the Allen dense-air refrigerating machines, and shows a marked and simple antithesis right at the beginning of the entire theory.

If we do not limit our definition of refrigeration to cooling from atmospheric temperatures, but regard it in the general sense of cooling at any temperature to a lower temperature, the analogy between the entire heat theory and corresponding refrigeration conditions becomes perfect. While the principle of reversibility exists in every case, in some only the heating side has developed its practical significance, and in others only the refrigerating end has received practical attention; but wherever and however heat is developed or used, we can reasonably look for the reverse case, that of heat absorbed or used for refrigeration.

Heat is given out or absorbed today in chemical reactions, in change of state, in work transformations, in electrical phenomena, and in the dissociation of atoms, as in radium. We have every reason to believe that all, and we know that most, of these actions are reversible; that is, heat can be given out or absorbed in any one of them, and refrigeration occurs when heat is absorbed or disappears as sensible heat, since this means a fall in temperature unless this heat is supplied from another source. Thus, in chemical reactions, steam can be dissociated at a very high temperature, and in so doing it absorbs heat and would cool off the mass, if heat were not constantly supplied from a furnace. This heat can be readily obtained again by exploding the two gases at a lower temperature. This actually occurs in the production of water gas, and the process is in reality a refrigerating machine and cools the coals in the furnace. In the same sense, iron in its production in a blast furnace is also a refrigerating machine. An electric current, in what is known as the Thompson effect, produces heat or cold in a metallic junction depending on the direction of the current. Radium in dissociating gives out an immense quantity of heat and we have every reason to believe the process is reversible. A steam engine in cooling off the steam in the cylinder by doing work is a refrigerating machine as much as the machines built for that purpose. The processes of chemical reactions, electrical effects, dissociation of atoms, etc., are at present purely physical processes and offer no hope of practical development in the restricted sense of refrigeration from atmospheric temperatures, although a partial utilization of the heat of chemical combinations, in a form known as "heat of solution," has been made to a limited extent, both for heating and refrigeration. Sulphuric acid or an alkaline metal disolved in water produces an intense heat, so great that it has been used for making steam for power purposes. In the same way, salt disolved in water absorbs heat and produces a mild cooling effect.

The two remaining methods of heat production, namely, change of state and transformation of work into heat, are readily reversible under almost all conditions and are utilized in some form or another in the majority of the practical developments in this field. Steam heating owes its efficiency to the fact that steam in condensing gives out its latent heat of vaporization in the form of sensible heat. All freezing mixtures, such as ice and salt, owe whatever efficiency they may possess to the fact that the ice melts and in so doing absorbs its latent heat of liquefaction from surrounding bodies. All matter, gaseous, liquid, and solid, gives out or absorbs heat in a change from any one of these states to any other. In general, solids absorb heat when liquefied, and liquids absorb heat when vaporized, and the process is reversible. In all cases these two phenomena are coincident. Heat is always a by-product or an ingredient in a change-of-state transformation. If heat is furnished or absorbed in sufficient quantity, change of state always occurs. If change of state can be produced by artificial or natural means, heat is always produced or absorbed. According to the kinetic theory, the kinetic energy of the molecules is transformed into molecular potential energy, or vice versa; but whatever the explanation, this fact is the basis of the steam engine and the most successful refrigerating machines. In the one, vaporization is produced by furnishing heat to a liquid, in the other cold is produced by absorbing the heat required for vaporization. The ammonia machine produces cold solely by the vaporization of ammonia liquid. The vacuum machine absorbs both sensible heat and latent heat of solidification from water by vaporization of water.

Liquids which are volatile at atmospheric temperatures and available pressures must, after vaporization, be reliquefied by cooling and pressure and used in a closed cycle. Increase of pressure means work to be done, so that in both steam engine and refrigerating machine two factors enter, heat and work. In the steam engine, heat flows from a high temperature to a lower one and work is given out. In the refrigerating machine work is put in, and heat made apparently to flow from a low temperature to a high one and thus further lower the low temperature. The vaporization of the liquid, in both cases, is merely one of the instruments by which the process is accomplished. In fact, it is only a more efficient tool and either process can be readily carried out with any permanent gas, such as air. In the first case, the most typical example is the Diesel engine, and in the case of refrigeration, that of direct cooling of air by making it do work. They are both almost true Carnot cycles, one in one direction and the other in the reverse direction.

A close comparison of the two processes at this point shows surprising conclusions. In order to see this yet more clearly, we cannot do better than to employ an analogy quite common in thermodynamics and explain its symbolic significance step by step as we progress. It is a common idea in the treatment of the subject of heat to regard it in the nature of a substance or fluid, and usually water is taken as representative. This concept is obvious and often almost necessary to many people in their treatment of the subject. Temperature is considered as water level, the height being always directly proportional to the absolute temperature, and the force which tends to pull the water to the lower level is the entropy. The analogy is perfect. Work done in the case of raising water is the force of gravity times the height; in the case of heat, the work done is the entropy times the rise in temperature. Water at a high level can be used to get work by letting it fall to a lower level, with a proper mechanism; but the amount of work obtainable depends on the mechanism and the highest and lowest level of the water. In the case of heat, work is done by letting a quantity of heat sink from a higher temperature to a lower one through a proper mechanism, and the amount of work obtainable depends on the highest and lowest temperatures used and on the form of the mechanism. The working substance—air, steam, or ammonia—has its best analogy in a sponge which is used as a holder for the water to raise or lower it, and the arm that raises and lowers and squeezes and soaks up the sponge is the steam engine or refrigerating machine, The furnace or source of heat in the steam engine is a leaky barrel filled with water and raised above the common water level. In the case of refrigeration, the cold-storage room is the leaky barrel sunk below the common water level and partly filled with water, and the water or heat is always in the first case leaking out from the boiler and in the second case, is always leaking into the cold-storage room. The sponge goes through four operations in a cycle in each case. It soaks up water in the barrel, it is then taken out to the common water level, it is then squeezed and the water removed, and it is taken back into the barrel and the process repeated. In the case of the steam engine or motor, the sponge soaks up water in the barrel, or the working substance soaks up heat in the boiler; the saturated, heavy sponge does work in falling to a lower water level, or the hot substance does work in going through the cylinder; the sponge is squeezed and the water escapes, or the steam goes into the condenser and the heat escapes: and last, the partially dry sponge is carried back to the barrel, or the water is taken into the boiler, and less work is done in lifting the sponge back and less work is done in forcing the water into the boiler. The cycle with the sponge is more nearly identical to the four operations in a Carnot cycle than to this one, and the four operations with the sponge are almost true analogues of the four transformations, two isothermal and two adiabatic, that occur in the Carnot cycle. In the case of refrigeration we can consider that the sponge soaks up water in the barrel or the ammonia liquid absorbs heat in the cold room; the sponge is lifted to the common water level and work done, or the ammonia goes through the compressor and work is done; the sponge is squeezed outside and water escapes, or ammonia goes to the condenser and loses its heat; and last, the partially dry sponge drops back into the barrel and can be made to do a little work from its weight, or the ammonia liquid goes back into the cold-storage room.

Strictly speaking, the analogy of the sponge is closer, when the working substance is a permanent gas, and the analogy can be extended much further without much profit by considering a condensable vapor and its liquid as a tin can and a sponge, the tin can or the liquid holding more water or heat and not leaking as readily and being more easily emptied; but the sponge analogy becomes startling when we compare its behavior in its cycle and the various losses encountered, with the working substance in the motor cylinder (or the compressor cylinder) in its cycle, with the various losses encountered in these circumstances. In the motor case, water is constantly leaking out of the sponge and falling without doing useful work and a portion may be squeezed out in handling and be drawn back if caught in time, but extra work is lost. In the cylinder, heat drips out of the working substance and it may be taken out and drawn in again in the cylinder condensation and re-evaporation. In the compressor cylinder a similar analogy holds for reheating, in that the sponge when squeezed dry at the top gets some water before it gets to level in sunken barrel.

Now if we ask ourselves why are water and ammonia the best working substances in heat motors and refrigerating machines, the answer is quite plain from analogy—that they are the best and most suitable sponges available for the purpose. What are the requirements in a suitable sponge? It should be capable of holding a lot of water, it should not leak readily, it should be easily squeezed, it should not be too large or too heavy itself to work. Translated, this means that a working substance should have high latent and specific heats; it should be capable of changing its temperature readily when work is done—that is, it should be a gas or capable of gaseous form at one stage; it should not be too large—that is, the working pressures should be medium and not change much with temperature; and the density should be high. Water and ammonia satisfy these requirements to a high degree for their respective temperatures and the only reason that water is not used as a refrigerating substance is that, as a sponge, its size and weight is inconvenient at that temperature—that is, its vapor pressure is very small and so is its density.

This brings us to an interesting question. What is the possibility of more suitable sponges or more suitable working substances being discovered for both motor and refrigeration work? As has been said before, it must be a sponge capable of holding much water and of giving it up readily. Water flows from a sponge only by difference of pressure; this is equivalent to a difference of water level, and this in the last analogy means a difference of temperature, so that heat can be taken from a working substance only by compressing it until it gets hotter than surrounding bodies. This is the equivalent of the isothermal change in a gas and the lifting and lowering of the sponge is the equivalent of the adiabatic changes. These changes are brought about by changes in volume and pressure, rapidly or slowly, and a gas or volatile vapor lends itself to these changes with less losses or extra work than any other substance. The use of a condensable vapor rather than a permanent one, means simply a cutting down in the size of the sponge for a given water capacity. Hence we see that a working substance should be a vapor with its boiling point near the lowest temperature in the cycle, and should have a high specific heat and a high heat of vaporization, and should have a high vapor density but a very low coefficient of vapor-pressure increase. The latter statement is equivalent to saying that the sponge should not be heavy in itself.

Now the rules determining the latent heats of substances, or at least the empirical relations between these and the boiling points, molecular weights, vapor densities, are well known, and in order to have definite conditions satisfied in regard to one we must necessarily have similar definite conditions satisfied in regard to the other. For instance, the law known as Trouton's Law (named after its discoverer) is fairly general for all substances and says that the product of the latent heat into the molecular weight is always proportional to the absolute temperature at which the change of state occurs. This is the same as saying that the latent heat of vaporization times the molecular weight divided by the absolute boiling temperature is a constant for all substances, and this is nearly true in every case. Therefore if we make limiting conditions in regard to latent heat and boiling points, through a consideration of this law, we will get limiting conditions in regard to molecular weight. Thus for a given boiling point, the lower the molecular weight the higher will be the latent heat of vaporization. Thus for water, the molecular weight is 18, the latent heat 966, and the boiling point 373 degrees absolute. For ammonia, the molecular weight is 17, the latent heat is 586, and the boiling point 241 degrees absolute, and the constant in the two cases is approximately the same. The molecular weight must therefore be low, and ordinarily, the fact that a substance has a higher molecular weight than water is almost conclusive evidence that its latent heat is lower than that of water if its boiling point is not abnormal. Now the number of substances that possess low molecular weights and normal boiling points is very small indeed. All the natural gases have low molecular weights, but very low boiling points, and therefore the pressures of the gases are too high at normal temperatures. The liquids which have been used as working substances in heat motors and refrigerating machines comprise almost all the known liquids at all suitable for the purpose, and of all these, ammonia, when all the influencing factors are determined, has been integrated to give the highest efficiency. The only possibility of its being superseded is the discovery of some new substance, or the changing of mechanical conditions so that some of the determining factors at present considered do not carry the same weight.

We have come now to the analogy of the purely mechanical parts of the motor and refrigerating machine, and those affecting the design of the mechanism. The furnace and the cold room, the boiler and the shell cooler, and the steam and ammonia condensers, serve the same purpose at different points in the cycles, and the engine and the compressor perform a directly opposite function in the two cases. Every little improvement in the steam finds its analogue in refrigeration. High pressures are more efficient but more troublesome in both cases. A wide pressure range makes for efficiency in steam-engine work, a low one in refrigeration. Triple expansion in steam and three-stage compressors increase the efficiency in each case for the same reason. Steam jacketing a cylinder to prevent initial condensation finds its analogue in water cooling the compressor to promote it. There exist similar cyclic flows of heat into and from the walls of the cylinders, with diminished efficiency in both cases. Superheating the steam finds its analogue in wet compression for ammonia. The analogue can be extended much further, and it becomes obvious that any improvement in steam engineering permits of a similar one in refrigeration. The advent of steam into the rotatory field with the steam turbine is but the precursor of similar work in compressors with corresponding effect on refrigeration. The development of the gas engine and the elimination of steam as a working substance is the forerunner of similar work in refrigeration, with the elimination of ammonia as the working substance.

The future refrigerating machine will probably be of this type. It will have a cycle similar in some respects to that of the Diesel motor and will utilize the heat of chemical combination, possibly combined with that of change of state. The direct utilization of electricity for this purpose offers an inviting field for research. The search for a more suitable substance than ammonia as a refrigerating agent is hopeless, I believe, as far as the utilization of the heat of change of state is concerned. Changes in mechanism are bound to come, and these will follow along similar lines to that developed in the best steam practice.

THE UNITED STATES COAL STRIKE AND ITS MEANING.

The negotiations in the coal strike in the United States are so subject to change from day to day that no attempt can be made here to present the situation from a news point of view. Mr. Saward brings out instead the fundamental facts and conditions in the industry, the relations of the soft and hard-coal fields to each other, the comparative quantity and disposition of their output, the basis upon which the operators and the miners have heretofore been working, and the points at issue in the strike of 1906. This will enable the reader not so closely familiar with the question to understand not only the position now reached, but the permanent relations of the various parties involved and the perennial sources of agitation which, whatever agreement may now be arrived at, may be expected to reassert their influences again in the future. The article is thus a valuable contribution to the permanent literature of the subject. — THE EDITORS.

THE month of April, 1906, has brought the American coal trade to the climax and a very considerable crisis, and it is therefore well to gather up the facts connected with the industry; they can be largely shown by statistics. The struggle that has been pending for months and has now come to an issue is between the labor organization known as the United Mine Workers of America and the owners and operators of the mines—both in the anthracite and in the bituminous fields of the United States.

The situation as of April 1, 1906, may be briefly summed up and stated thus: An agreement between the operators and the United Mine Workers engaged in mining in the competitive soft-coal producing districts of Ohio, Illinois, Indiana, and western Pennsylvania, was entered into in 1904 for a term of two years; a reduction of 5 cents a ton from the 1903 basis of 90 cents a ton for screened coal, passing over 1¼-inch screen, was to be the rate for the period up to April 1, 1906. At joint conventions held in February, 1906, the men asked for an advance of 12½ per cent over the existing basis. No result was had. A further joint convention, held in March, resulted in the miners granting permission for any operation to resume where the employees could get the 1903 basis—a restoration of the 5 cents a ton taken off in 1904.

In the anthracite industry, the award of the Roosevelt Strike Commission (made as a result of the long strike in 1902, which award dated from April 1, 1903, and was to hold for a term of three years) also expired in April of this year. Thus the effect would be, if a general strike order were issued, that mining of all grades of coal in districts subservient to the United Mine Workers would stop on April 1, 1906. The men in the anthracite districts, through a committee appointed by the Shamokin Convention of December, 1905, prior to the date of expiration of the three-years' agreement, presented a number of claims—"suggestions"—for a renewed basis of operations from that date forward, which would materially enhance the cost of coal. The anthracite operators stood firmly for the continuance of the conditions which had existed during the preceding three years. While negotiations looking to a settlement were going on, and after several conferences of the two opposing forces, by committee, the president of the United Mine Workers, on March 29, issued an order to the employees in the anthracite region instructing them to cease work on Monday, April 2.

In the first instance it must be said that while the United Mine Workers do not control all the laboring people—that is, they are not all yet in the order—the suspension of those who are affiliated, in the States where they are strong, usually puts the others out of work. The union is particularly strong in Illinois, Indiana, Ohio, and in the western part of Pennsylvania, with a scattering of forces in other States. The list of membership is nearly 400,000, "in good standing," according to recent official figures given out.

The details are shown below:—

Pennsylvania;	
Anthracite, Districts 1, 7 and 9	80,490
Bituminous, Districts 2 and 5	59,526
Indiana;	
Block, District 8	2,411
Bituminous, District 11	12,603
Ohio; Bituminous, District 6	34,644
Washington; Bituminous, District 10	465
Illinois; Bituminous, District 12	51,478
Iowa; Bituminous, District 13	10,957
Kansas, Bituminous, District 14	9,019
Colorado; Bituminous, District 15	446
Maryland; Bituminous, District 16	246
West Virginia; Bituminous, District 17	6,155
British Columbia, Canada; Bituminous, District 18	2,269
Tennessee, Bituminous, District 19	3,156
Alabama; Bituminous, District 20	3,215
Indian Territory; Bituminous, District 21	12,530
Montana and Wyoming; Bituminous, District 22	1,883
Kentucky; Bituminous, District 23	2,942
Michigan; Bituminous, District 24	2,272
Missouri; Bituminous, District 25	7,809
Total	304,516

These would not all be included in the strike recently in force, by reason of the disagreement at Indianapolis, for the membership in the States involved in the Inter-State agreement is not 130,000 persons. The first joint convention, in February of this year, held at Indiana, ended in a deadlock, because the men wanted an advance of 12-½ per cent over what they had received in 1904-6, and the operators refused to give this, or even to offer a compromise of any kind. Then it was that a second effort was made to relieve an otherwise desperate situation, and another joint convention was held at the end of March, when it was found that the only way out was to permit any district which could do so to make a bargain for a return to work on the 1903 basis, which means a restoration of the 5.55 per cent taken off in 1904, giving 90 cents a ton for screened coal as the basis.

These soft-coal operatives have not been poorly paid, and their advances in the past few years have been many and great. The schedule is shown in the following:—

	Pick Mining.	Hours Worked.	Drivers, per day.	Inside Men, per day.
1896	45c.	9 and 9½	$1.40	$1.40
1897	51 and 56	9 and 9½	1.52½-$1.65	1.52½-$1.65
1898	65c.	8	$1.75	$1.75
1899	65c.	8	$1.75	$1.75
1900	80c.	8	$2.10	$2.10
1903	90c.	8	$2.56	$2.36
1904	85c.	8	$2.42	$2.23
1905	85c.	8	$2.42	$2.23
1906	90c.	8	$2.56	$2.36

Coming to the anthracite situation, the men there have been ordered out. This was done while negotiations were pending looking to an adjustment of the wage basis for another period, and after they had worked under the Anthracite Strike Commission award of 1903. The loss of work will cost the anthracite miners an aggregate of something like $370,000 a day in wages. This would be at the rate of over $2,218,000 for a week of six working days, and about $8,875,000 a month. These figures are based on the number of men employed and the average wages paid since the award of the Strike Commission has been in effect. The miners worked 231 days in 1904, receiving therefor $85,519,291.

The total wage cost of anthracite mining, according to the figures compiled by the State Bureau of Mines at Harrisburg, Pa., was more than double that paid employees in the bituminous mines and the daily and yearly individual pay of anthracite working men is greater than that of the bituminous miner in every case except that of the men outside.

Tabular Statement of Pay of Coal Miners in the United States.

	Anthracite		Bituminous.	
1904. Details.	Yearly.	Daily.	Yearly.	Daily.
Average	$626.77	$2.71	$431.02	$2.29
Men; miners	684.78	2.96	418.15	2.22
" miners' laborers	462.18	2.00	.....	...
" inside	780.58	3.38	492.15	2.62
" outside	541.62	2.34	475.36	2.53
Boys	241.31	1.04	165.99	.88

As to the destinations of the shipments of anthracite, showing the section of the country most affected, the following may be taken:—

	Tons.
Pennsylvania, New York and New Jersey	41,000,000
New England States	8,700,000
Southern States	2,100,000
Western States	7,070,000
Pacific Coast	5,000
Dominion of Canada	2,500,000
Foreign ports	35,000
Total	61,410,000

The division of the shipments of anthracite from the collieries by sizes during the past year was as below:—

Lump	2.62 per cent	1,609,885 tons.
Broken	6.90 " "	4,238,069 "
Egg	12.31 " "	7,562,414 "
Stove	19.16 " "	11,765,449 "
Chestnut	19.91 " "	12,249,398 "
Pea	13.71 " "	8,419,097 "
Buckwheat	14.62 " "	8,979,273 "
Smaller	10.73 " "	6,586,614 "
Total	100 " "	61,410,199 "

In addition to the small coals in the above statement was the amount produced at the washeries, amounting to 2,644,000 tons. If one puts all this into the list of coal in the East competitive with bituminous, there is a total of 27,000,000 tons.

The output of prepared sizes and steam sizes by regions in 1905 was:—

	Wyoming.	Lehigh.	Schuylkill.
Prepared	22,823,157	4,517,861	10,084,200
Small	13,034,741	3,331,344	7,618,899
Total	35,857,898	7,849,205	17,703,099
Prepared (per cent)	64.66	57.56	56.96
Small	35.34	42.44	43.04

The total production of marketable coal (Ruley's figures) in all the regions was 61,410,201 tons, of which 37,425,217 tons, or 60.94 per cent was prepared coal and 23,981,984 tons or 39.06 per cent small sizes.

The anthracite-miners' committee of the United Mine Workers has formulated a number of claims for advances for another season from April 1st, 1906, which would, very naturally, increase the price of coal to the consumer. Anthracite coal-mine operators offered to compromise with the miners and avert a strike. At first they demanded a reduction in wages, while the miners asked for an increase. Later they said that they would agree to abide by the terms imposed by the Anthracite Commission three years ago for another period of three years. These terms include a nine-hour day, a 10-per-cent increase in wages over that they had previously received, and a percentage on all increases in price. It is open to serious doubt whether the miners would have been able to exact such terms had the last contest been fought out to a finish. It is still more doubtful now if they can wrest further concessions from the operators. Even if by any freak of fortune they should win in a strike, their gains would be eaten up by their loss during the period of idleness.

It is not denied by the miner interests that the anthracite workers have enjoyed, during the last three years, a period of prosperity almost unprecedented. They have had the full benefit of the rise of coal prices, and it is only the public that has suffered. This was assured by the sliding-scale plan, which guaranteed increase of wages with the increase over $4.50 per ton price at tidewater, and held wages firm should the rate fall below that. All the reports from the anthracite fields, indeed, have indicated that the miners, individually and as a whole, are satisfied with their condition.

The anthracite operators say, in regard to the demands made by their employees, that they are excessive and without warrant, comprising as they do:—(1) An increase of 10 per cent to all miners engaged in cutting coal, or other men engaged on contract work. (2) The establishment of a minimum day wage for each class of labor: this minimum day wage, in many instances, is 100 per cent greater than the rates now being paid. (3) The establishment of an eight-hour day, instead of a nine-hour day, without any reduction in a day's pay.

By careful calculation from the payrolls of the operating companies, the effect of these three increases is to add an average of 21.64 per cent to the actual labor cost per ton of coal. This is equal, at the present labor cost of $1.55, to an increase of 33,68 cents per ton on all sizes of coal which are mined. Inasmuch as so large a proportion is small coal, which comes in competition with bituminous, therefore selling at a low figure, the cost of domestic sizes is thus increased. This placing of the burden on the domestic sizes—a fact against which there is no appeal—brings it about that the labor cost of each ton of coal sold to the "domestic" consumer would be raised under the new demands by 51.8 cents a ton. The question is, then, whether the consumer will agree to pay a further increase in the cost of his domestic fuel.

The total tonnage of the country has grown at a rapid rate. The results are shown, in net tons, below:—

Year.	Anthracite.	Bituminous.
1880	28,649,000	71,067,000
1890	46,460,000	111,318,000
1900	57,379,000	209,700,000
1905	76,475,000	308,925,000

As stated earlier in this review of the situation, the permitting of any district in the organization of the United Mine Workers to make terms rather weakens that organization. At the same time it tends to a disruption of the Inter-State agreement plan and idea. Much has been said about the "tight contract" to which the miners have bound the Illinois operators during the last few years, and their position in relation to their competitors and to their markets has been a subject of much remark and not a little writing. The fact is—and it is and has been the dominating fact—the miners of that State are compactly organized; have a large fund available to conduct detail fights, and have been led by men of radical ideas, even for miners. It would seem, from the results of the last Indianapolis convention, that the Inter-State agreement as at present organized is a dead issue, and that Illinois and Indiana must get together, and that Ohio must link her fortunes with the Pittsburgh district, or, like the latter, go it alone.

Naturally, under the conditions that have existed since the first of the month, there has been an excited market for coal, and prices have for the time being advanced in some instances a dollar or more per ton over the former price. Producers of soft coal have naturally raised their prices to the basis of $4 for gas slack and ordinary steam grades, and $4.50 for specialities, f. o. b. New York harbor shipping ports. Consumers are clamoring for all the bituminous coal they can lay their hands on, as they realize that the situation will soon be taken advantage of by the speculative interests. All the leading anthracite operators and coal-carrying roads have agreed not to raise their prices on the accumulations of hard coal, which they have been storing for several months, until they have exhausted all that they can sell, and still have a moderate surplus for themselves. The official circular prices, in accordance with the agreement of the operators, remain unchanged as follows:—Egg, stove, and chestnut, $5; broken, $4.75; pea, $3; No. 1 buckwheat, $2.50; No. 2 buckwheat, $1.85; rice, $1.40. At the same time, any coal that is available, as in yard, or due on contracts to the commission houses, had been increased fully a dollar a ton over these figures before the first week in April had passed.

The conditions have thus far been discussed that the reader not familiar with the situation may have a clear understanding. The national organization of mine workers in the United States has attempted to shut down every mine in the principal coal-producing States—not permitting any competition of one grade with another, in order to force the producers to give way and pay the scale demanded. In effect, one has the condition presented to the American people that its coal supply must be produced by union labor, that wages for producing it shall be whatever they may demand, that these demands will continue whenever in the opinion of the mine workers' union the occasion would seem to warrant such demands. It is a sample of the arrogance of the labor element and a defiance of the American idea that there should be a square deal for everyone. The power exerted by the leader of the United Mine Workers', who can call idle hundreds of thousands of men, is unequalled by that of any sovereign in the world, and it remains to be seen how long it will be before the nation will awaken to the conditions in the coal-mining industry.

EDITORIAL COMMENT

THE conditions at San Francisco are too overwhelming and the reports still too chaotic for more than elementary deduction. Two important facts seem certain:—first, that if fireproof construction had been general in San Francisco, the loss would have been but a fraction of what it is; and second, that the steel-skeleton building exceeded even the best hopes of its advocates in resistance to the earthquake. The type evolved out of the conditions of the newest civilization has proved itself best adapted to cope with the violence of primeval forces.

The steel framework and reinforced concrete offer trusty armor to the undaunted city, already rising to fight again. But in the years of emergency and stress that lie between the present ruin and the San Francisco of the future, what part are the labor unions going to take?

* * *

The announcement of the early retirement of Professor F. R. Hutton as active secretary of the American Society of Mechanical Engineers comes as a surprise to many of his friends in the Society, but this is coupled with a sense of satisfaction when it is learned that he will continue as Honorary Secretary and give as much of his time as is practicable to the furtherance of the work of the organization to which he has devoted twenty-three years of active service.

There are few men who can point to such a long period of devoted and successful work as can Professor Hutton in connection with the upbuilding of an organization which has grown from small beginnings to a position in which it is one of the dominating influences in the applied science of engineering in the United States; and it is with a feeling of unqualified praise that we express what we fully believe is the opinion of the whole profession in all parts of the land, when we state that without the work which Professor Hutton has so well done, the American Society of Mechanical Engineers would not have attained its present commanding position.

* * *

In connection with the present discussion of the compulsory introduction of the metric sytem into the workshop, a recent communication of Professor Gisbert Kapp to the London Times is of interest. After advocating the use of the C. G. S. system in connection with electrical computations, Professor Kapp says:

"I have never suggested that the metric system should be adopted in the English machine shop. What I did suggest was that the scientific part of the electrical engineer's work should be done on the basis of the C. G. S. system. Having finished his design, the engineer may then finish his working drawings in any system of units he pleases. The mental labor required to translate centimetres into inches is trifling, and I do not think anyone can reasonably object to figuring working drawings in inches, although the calculations of which these drawings are the result, may have been done in the C. G. S. system."

In other words, an engineer, brought up in the midst of the metric system, sees no good reason for any change in the workshop practice of the United States or Great Britain, although he himself advocates the employment of the metric system for electrical computations.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

TELEPHONE ENGINEERING.

THE RELATION OF THE ENGINEER TO THE SOLUTION OF THE TECHNICAL AND COMMERCIAL PROBLEMS OF TELEPHONE COMMUNICATION.

J. J. Carty—American Institute of Electrical Engineers.

WHEN the telephone was first introduced the technical problems connected with its installation naturally fell into hands of men expert rather in the department of telegraphic communication than with the wider questions of engineering, and it has only been within the past ten or fifteen years that a distinct department of applied science known as telephone engineering has become firmly established. The magnitude and importance of the work of the telephone engineer is even yet not fully appreciated by many, and hence the paper presented by Mr. J. J. Carty at a recent meeting of the American Institute of Electrical Engineers is especially worthy of notice and review.

After mentioning the incidents of the progress of the telephone engineer from what may be termed a switchboard man to his present broad field of work, Mr. Carty illustrates some of the questions which arise for solution by discussing a typical example in telephone engineering:

"Let us take the case of New York City, with the suburban territory tributary to it, and assume that it is the intention of the telephone company to install within that territory a telephone system which will work at a proper degree of efficiency, and, at the same time, yield to the investor a fair return upon his investment; and that it is necessary not only that this condition should exist during the first stages of the project, but that the undertaking should be so managed that this condition will be maintained indefinitely. With such a problem before the telephone management, what part of it should the management require the telephone engineer to work out? I shall answer this question by describing in general terms, and sometimes for the purpose of illustration, in considerable detail, which should be the work of the telephone engineer in such a case.

"The first question which the engineer must decide is, what is the period for which such construction as may be required should be planned? This is a question of far-reaching importance, and requires for its answer that a vast amount of data should be collected, and that careful and long-continued study and investigation should be given to a large number of factors, involving, among other things, first cost and character of construction of the diverse portions of a plant of such complicated nature, annual charges, such as maintenance, depreciation and interest, and local conditions bearing upon the possibility of the renewal or extension at some future time of all of the elements of the plant.

"In addition to this, due regard must be paid to possible changes in the art, and also the fact that, owing to the exigencies of the business, many cases arise where it is necessary to carry out at the beginning, especially in underground work, all of the construction which may ever be needed.

"At the outset the question of the period for which to plan depends upon the expectations of growth. With a given expectation of growth, the engineer, by taking into account all of the factors of the case and balancing the annual charges resulting from the initial investment against the cost of reconstruction and rearrangement of the plant at some future time, arrives at the economical period for which to plan.

"In this work the predictions as to growth of the first importance, and inasmuch as accurate predictions of this kind are attended with the greatest difficulty, it is essential that not only the judgment of the engineer, but that of the business management, and all others who might be able to advise in connection with the matter, should be obtained.

"At this stage of the work it is of the utmost importance that the bearing of these estimates of growth upon the future of the plant should be thoroughly understood by the business management, whose functions, in the nature of the case, exercise such a profound effect upon the extent and character of such growth. It is the duty of the engineer to make this point clear, and to obtain from the business management serious and responsible estimates of future growth.

"The number of lines which may be expected having been agreed upon, the question of for how long a period ahead we should plan is determined by a number of circumstances. For such conditions as obtain at New York, the period for much of the construction has been found to be from seventeen to twenty years. This figure is arrived at by taking into account a large number of factors, such as life of the central switchboard—which is placed at about fifteen years, the relative costs of placing in the subways a large number of ducts initially as compared with adding new ducts after a period of about twenty years, the uncertainty regarding the changes in the state of the art, and the difficulty of foretelling with sufficient detail conditions which are expected to obtain during a period so far ahead as twenty years."

Mr. Carty then proceeds to discuss the manner in which the number and distribution of the lines are determined, including a study of the map, with location and boundaries of districts, situations of exchanges, offices, and switchboards. In all this layout of a vast scheme, including estimates for future demands in connection with economical provision for immediate business, there is ample scope for administrative and technical ability of the highest order. When to this are added the problems involved in the acquirement of real estate, the provision for suburban and long-distance connections, and the control of routes, something will be realized of the broad nature of engineering work, before any constructive problems have been attacked at all.

The whole question of the work of the telephone engineer bears testimony to the extent to which engineering has become interwoven with commercial questions. The physical problems belong to the various branches of applied science falling within the work of the civil, mechanical, and electrical engineer, but to these must be added a grasp of commercial and financial matters. Thus the adoption of the flat-rate or the toll-rate method of charging for service is intimately connected with the operations of the telephone engineer.

With the flat-rate method there was no definite relation between the service and the charge, and with the continually increasing service it became impossible to arrange for any determinate growth or distribution. This alone invited discouragement of the development of extension stations, internal exchanges, desk stands, and other auxiliaries tending to make the use of the telephone easy and, therefore, more frequent. The engineer, in endeavoring to plan his work in connection with the flat-rate plan, met with difficulties on every hand. The small users could not afford the necessarily high charge for the flat-rate, so that only those having a large number of calls could install a telephone, the result being a system largely composed of overloaded lines. A second line usually meant doubling the cost, and hence gave no aid in meeting the question.

As soon as the message rate was introduced, it became possible to furnish the service to many to whom it had formerly been impossible, while at the same time it became the interest of the company to encourage the use of the telephone in every manner. Local switchboards and separate instruments were installed at very moderate charges, because their presence caused a natural development in the use of the line, with a proportionally increased revenue, and the whole situation became changed.

"Considering these two examples of the method of charging which shall be followed upon toll lines, and the method of charging which shall be adopted upon subscribers' lines, it will be seen that they in a most extraordinary manner affect the work of the telephone engineer. So profoundly do such considerations affect the proper engineering of the telephone plant that it must be said that good telephone engineering can not exist side by side with a bad system of rates, or with improper business methods and organizations. Nothing more forcible than these examples needs to be mentioned in order to show the intimate relations between telephone engineering and business management.

"From time to time, engineering methods involving new principles are brought forth. These, when found to affect the methods of the business office, should be submitted to the business management with a full and clear statement of their bearings upon the commercial work of the company. On the other hand there are, from time to time, business proposals and commercial methods which are under consideration by the business management of telephone companies, and which, apparently, are only remotely, or not at all, related to engineering. In view of the many unexpected and important reactions which these proposals may have upon the engineering of the telephone plant, it becomes of the first importance that they should be scrutinized carefully from an engineering point of view, unless it is conclusively apparent that they will be without effect upon the engineers' plans."

Mr. Carty gives some attention to the question of automatic systems as compared with the manual system, and shows that an extensive comparison of systems in regular working operation shows that the actual cost of the automatic method is greater than that of the manual switchboard, while the service is inferior.

The relations of the telephone engineer have thus reached a position vastly more important than could have been imagined at the beginning. He must broadly determine all of the important features of the plant of the company, and he must in detail decide what shall be the nature of the construction and the method of operation of every single item which constitutes the physical property of the telephone company.

"Viewed from this standpoint, 'it will be seen that while the function of the engineer with relation to the plant is of the utmost importance, nevertheless the work of the traffic, maintenance, construction and other departments has such an important bearing upon the whole system that the successful engineering of a telephone system must be regarded not only as the work of the engineer himself, but as the work of all the other departments concerned. Not only this, but what is still more important, the successful engineering of a telephone plant depends upon proper business management. Without an intelligent, progressive, and broad-gauged business management, there can not be good telephone engineering."

THE TEHUANTEPEC RAILROAD.

COMPETITIVE INFLUENCES OF RATES ON THE TEHUANTEPEC AND PANAMA RAILROADS AND THEIR RELATION TO THE PANAMA CANAL.

John F. Wallace—Railway Age.

IN the course of an address delivered before the Illinois Association, and published in the *Railway Age,* Mr. John F. Wallace gives some important and interesting indications as to the relation of the recently completed Tehuantepec railroad upon isthmian traffic. This railroad, constructed in the interests of British capitalists, is an extremely well built line, provided with the best modern facilities to handle a large amount of traffic at a minimum rate. It is expected that it will be possible to transport merchandise from ocean to ocean at a cost of not more than

$2 a ton, from ship hold to ship hold, the time from ship to ship not exceeding two days.

Taking the facilities of this route into consideration, and assuming as a fair ocean rate $1 per thousand miles, Mr. Wallace proceeds to give some computations of the cost of merchandise transport between various ports, as follows:

From New York to Australia, say the port of Sydney, the saving of distance by way of the Tehuantepec Railroad would be 5,700 miles, and any railroad rate across the Isthmus of Tehuantepec, less than $5.70 per ton, should take this business from the Suez route. In addition it would save the time it requires an ordinary cargo vessel to steam 5,700 miles, minus the time required to transfer the freight across the isthmus by rail. This would make an actual saving of time of at least 15 days, even allowing the maximum of four days for the isthmian transit.

From New York to India and China points, this route would not be so material, as the line of least resistance from a traffic standpoint would never be over the transcontinental lines through San Francisco, Seattle or other Pacific ports.

From Liverpool to points in the far East where the distance is the same, the Tehuantepec Railroad could charge the Suez tolls, which are approximately $2 per ton, and compete for the business with a fair profit.

Turning to the ports, however, in the United States, the advantages given by this route are also remarkable. From New Orleans to Hong Kong, the saving would yield the Tehuantepec Railroad $4.80 a ton on the basis of equivalent charges by the Suez route, in addition to saving from 12 to 14 days in time.

From New Orleans to Yokohama the saving over the Suez route would be 8,400 miles, which would enable the Tehuantepec Railroad to charge $8.40 per ton for the transit of freight on its railway, on an equivalent basis with Suez, and save approximately 24 days in time.

From New Orleans to Australia, the port of Sydney, the figures would be practically the same. As there is little question of the ability of this railroad to handle freight from ship to ship for $2 a ton or less, its ability to build up an enormous business to the far East in competition with the Suez route is plainly manifest.

Let us now compare the Tehuantepec route with that of the Panama Canal, on the same assumption that $1 per ton will carry ocean freights 1,000 miles and that $1 per ton will be the minimum rate charged for transit through the canal.

From Liverpool to Hong Kong, the saving in distance via Tehuantepec will be 1,200 miles, and allowing two days for the transit of the freight across the Isthmus of Tehuantepec, the saving of time will be approximately two days. The saving in distance will be equivalent to $1.20, which, added to the minimum charge of $1 through the Panama Canal, would give $2.20 as a maximum charge to the Tehuantepec Railroad.

From Liverpool to Yokohama the saving, as against the Panama route, will be 1,100 miles. From New York to Australia, port of Sydney, the saving will be 761 miles, which, on the same basis as just stated, would yield the Tehuantepec Railroad a maximum charge of $1.76 a ton, or approximately 1 cent per ton per mile, some 40 per cent higher than the average rate on the trunk lines in the United States.

From New York to San Francisco, the saving will be approximately 1,200 miles, which would yield $2.20 as a maximum rate to the Tehuantepec Railroad.

From New Orleans to Hong Kong, a common point for Northern China, the saving of the Tehuantepec line over Panama is approximately 2,000 miles, which would permit the Tehuantepec Railroad to charge a maximum of $3 per ton on an equivalent basis, and save in time approximately five days.

From New Orleans to Australia, port of Sydney, the saving would be approximately 1,400 miles, allowing the Tehuantepec Railroad a maximum charge of $2.40.

From New Orleans to Honolulu the saving would approximately be 2,000 miles, permitting the Tehuantepec Railroad to charge a maximum rate of $3 per ton.

From New Orleans to San Francisco the saving in distance via the Tehuantepec route would be 1,800 miles, permitting the Tehuantepec Railroad to charge a maximum of $2.80 a ton, with corresponding saving of several days in time.

It must be remembered that these figures represent rates which are about available at the present time, or at least upon the opening of the Tehuantepec route to traffic. Trade is more or less conservative, and clings to established routes unless important advantages can be shown in favor of a change, and during the years which must elapse before the Panama canal can be opened to traffic the Tehuantepec route will have established itself as on definite lines with which the canal will have to compete.

Mr. Wallace shows that the proper way to meet this possibility is to create a competition immediately by means of the Panama railroad. By the immediate provision at Panama of the proper facilities and equipment for the maximum efficiency of the Panama Railroad, and the putting in of a flat rate of not more than $2 a ton, and possibly as low as $1.50, the diversion of traffic from that route can be prevented, while the traffic tributary to it can be encouraged and expanded, and the business thus built up will be ready for the canal when completed.

A rate as low as $1.50 a ton—which will give an average of 2 cents per ton per mile for transit over the isthmus, and allow 50 cents per ton for the handling of freight from ship to car and from car to ship—would be ample after complete facilities for handling the business had been provided and the business had increased to a sufficient amount to justify it—say to 1,000,000 tons per annum.

So far as the mere question of rate is concerned, with the only disadvantage of breaking bulk, this rate would immediately enable America to compete with the Suez Canal on all traffic from the United States ports to the far East, and from the ports of Europe and Australia, Japan, China, and all points east of Singapore, and, so far as trade with the west coast of South America is concerned, this would give the United States, particularly the Mississippi Valley, a decided advantage over all the ports of Europe, and would enable the larger part of the advantages of the Panama Canal to be anticipated. It would give American merchants and manufacturers such a foothold in this trade, provided it is properly catered to and developed, as would enable it to be held, at least in part.

The failure of the United States to improve and utilize the Panama Railroad to its full capacity, and do it at once, may seriously affect the value of the government Panama investment, which has already reached 70 millions of dollars, and may reach 300 millions.

The great direct benefit of a flat rate of $2 a ton or less across the Isthmus of Panama by rail will at once put the United States in a position where, for a comparatively small investment not exceeding 2 per cent of the total cost of the canal—which investment should be made in any event, in order to assist in its constructiona large percentage of the ultimate advantage to be derived from the canal commercially, will be secured. The greater part of this benefit will lie in the reduction of rates, which will result to the benefit of the agricultural and commercial interests of the countries in Central and South America bordering on the Pacific below the Mexican line.

While the proportion of rates which have accrued to the Panama Railroad on business from New York to San Francisco has been low and reasonable, its charges on the traffic passing over the isthmus to and from the countries bordering on the Pacific Coast in Central and South America have been exorbitantly high, and have been kept by the countries affected thereby. It will without causing the traffic to be diverted around Cape Horn. The rate which accrued to the Panama Railroad on coffee from Costa Rica has been as high as $6 a ton for the distance across the isthmus, say 50 miles. A lowering of the rate to $2 a ton or less will stimulate all forms of agricultural and commercial enterprises in the countries affected thereby. It will largely increase the population and the consuming capacity of these countries; and if this trade is properly fostered and catered to by American manufacturers and merchants it should yield large benefits and cement the politial, commercial, andc frDbe cement the political, commercial and personal friendships between the United States and the nations of Central and South America.

In view of the above facts it appears to be high time for the United States Government to realize the situation and use the Panama Railroad to meet this competition.

THE POWERING OF MACHINE TOOLS.

EXPERIMENTAL DETERMINATIONS OF THE POWER REQUIRED TO DRIVE STANDARD MACHINE TOOLS WITH REFERENCE TO ELECTRIC DRIVING.

G. M. Campbell—Engineers Society of Western Pennsylvania.

BEFORE the introduction of electric driving there existed some very erroneous ideas as to the power required by various machine tools in performing such ordinary shop operations as turning, boring, planing, drilling, and the like. Designers of tools had learned by experience about how they should be belted, and it was well known that anywhere from 30 to 50 per cent of the engine power was consumed in getting the power to the work, but the actual distribution of the power among the various tools was largely a matter of guesswork. Some tools and machines were known to absorb what seemed like disproportionately large amounts of power: and wood working machines, such as planers, surfacers, and similar machines, as well as fan blowers, were known to be great consumers of power.

When the electric motor came into use it brought with it, among its many advantages, the opportunity of determining accurately and readily the actual amount of power delivered at any moment, the result being a large access of information concerning the power required in the different workshop operations. The information thus acquired has again reacted upon the motors themselves, being used in the proportioning of the motors, as well as in what may be called the powering of the machine tools, or the selection of the size and capacity of the motors to be used in the various cases. In a paper recently presented before the Engineers' Society of Western Pennsylvania by Mr. G. M. Campbell some of the considerations which govern the powering of machine tools designed for direct electric driving are given, including the results of many practical tests, tabulated and compared with the computed amount of power indicated by empirical formulas.

Apart from the supply of the maximum amount of power required, one of the most important considerations in connection with electric driving appears in the necessity for a satisfactory speed control.

In machine tool work speed variation is essential, and in a machine driven by an individual motor part of the speed variation must be obtained in the motor itself if efficient speed control is required. The range of speed required in some machines may be quite limited, on account of the particular class of work for which the machine is used, and in such a case the full range of speed could be supplied by the motor. On the other hand, the speed variation required may be so great that it is impossible to supply it all by the motor.

Just what range of speed is required in the motor cannot be definitely stated for all conditions. If a total speed range of six to one is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds four to one, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about three to one.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary approximately as the speed and cut, and therefore as the weight of metal removed, consequently in fitting motors to tools alallowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high-speed tool-steels and the increase in rigidity of machines.

In general, the power required to drive a machine can be computed by multiplying the weight of metal removed per minute, in pounds, by a coefficient depending upon the kind and grade of the material. This coefficient ranges from 1.4 for cast iron, to 3.6 for hard steel, with intermediate values for materials of hardness between these limits. Of course, the condition of the cutting tool as much influence upon the power consumption, and a dull tool, or one of improper form, may cause a much greater amount of power to be uselessly consumed.

The friction losses in machine tools which run continually in the same direction, as lathes, drill presses, etc., are not very great, and, so far as can be ascertained, these losses do not bear any direct proportion either to motor speed or to spindle speed.

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take, this is the reciprocating tool, as the shaper and planer, and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives where motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a flywheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

With intermittent machines, such as shears, punches, and the like, in which the maximum effort occurs suddenly, it is very desirable that a properly proportioned flywheel be used, thus averaging the resistance, and rendering it unnecessary to provide a motor as large as the maximum load would indicate. Thus, in the case of a punch for which the power diagrams are given by Mr. Campbell, the maximum horse power rose to twenty-one, while a similar machine with a heavy geared flywheel, required but 7.9 horse power on the same test.

Mr. Campbell gives some interesting data and results of tests upon tools in the shops of the Pittsburgh and Lake Erie Railroad Company at McKee's Rocks. Thus, a 90-inch driving-wheel lathe consumed from 9 to 15 horse power, according to the depth of cut and the hardness of the material. The horse power required to remove one pound of metal ranged from 3.87 to 1.50, this showing the variation in the material under operation.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be restricted to, the grade of material, whether cuts, if heavy, will be of short duration, etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions—assume a cutting speed of fifty to seventy feet a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than thirty minutes, transfer this into pounds of metal removed per minute and multiply by 2.7, then select a motor which will develop this power throughout the range of speed desired.

MOISTURE IN SUPERHEATED STEAM.

EXPERIMENTAL STUDIES TO DETERMINE THE POSSIBILITY OF THE PRESENCE OF WATER IN STEAM ABOVE SATURATION TEMPERATURE.

By Fritz L. Richter---Verein Deutscher Ingenieure.

IN considering the advantages obtained by the use of superheating of steam in engines several points have to be considered. The primary question, doubtless, is the possibility of minimizing the losses due to cylinder condensation, by keeping the working fluid at a temperature farther above the point of liquefaction than would be the case with saturated steam. It has generally been assumed, however, that with even a moderate degree of superheat, the steam must necessarily be dry, and superheating has therefore been principally regarded as an effective means of preventing the entrance of entrained moisture into the engine cylinder. Of late, however, the accuracy of this latter matter has been questioned, and hence the careful experiments recently conducted by Herr Fritz L. Richter, at the mechanical laboratory of the Charlottenburg technical high school, and published in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* are to be welcomed as valuable contributions to a more accurate knowledge of the actual facts in the case .

Experience with superheated steam has demonstrated that there are various things neccessary to obtain the full benifit besides providing a means for superheating and an engine in which high temperature steam can be used without injury. Hot steam is practically hot gas, in so far as it parts rapidly with its heat to surrounding objects, and the researches of Dr. Berner have shown how important it is that the piping should be most carefully jacketed and protected against radiation losses. In like manner it must be noted that the presence of a separator, generally advisable with saturated steam, may prove a source of loss with superheated steam, permittng the temperature to drop, and becoming a place for the formation of moisture.

Moisture in steam mains may appear in two forms: it may exist as a thin film, in contact with the walls of the pipe, owing to the fact that radiation causes the pipe itself to be cooler than the core of the steam flowing through it; or, it may be in the form of drops, swept from the walls where it was formed, and carried along by the current of flowing steam. These two cases, as stated by Herr Richter, do not include the possibility of entrained water being carried bodily out of the boiler and into the pipe by mechanical action. Herr Richter is rather of opinion that in many forms of separators the sudden change of direction relied upon to remove the entrained water from the steam may do more harm than good, by causing the steam to pick up the water from the metallic surfaces to which it would otherwise adhere, and create such an intimate mixture as to render its subsequent separation a very difficult matter. However this may be, it is evident that experimental investigation is the only way in which definite information can be applied to the definite solution of the question, and for this reason the Charlottenburg researches are of importance.

The apparatus employed by Herr Richter consisted of a drum about 30 inches in diameter and five feet long, arranged so that the steam could be admitted in the middle of one head, the jet impinging upon a fixed cup similar in form to the bucket of a Pelton water wheel, the steam striking the cup on one side of the concave surface in such a manner as to cause the current to be entirely reversed and its velocity checked. Observation windows were arranged in opposite sides of the drum, and the interior illuminated by incandescent electric lamps in such a manner as to enable the action of the steam jet to be studied, and the presence of water and the formation of drops to be examined critically. In this respect the drum formed something like an enlarged arrangement of the "revealer" designed by the late Mr. Bryan Donkin for the study of condensation phenomena in the cylinders of steam engines. The drum was provided with drainage connections, mercurial gauges, thermometers, etc., so that the data accompanying any observation could be noted and recorded.

When saturated steam is delivered into such a drum the absorption of its energy by the checking of its velocity causes its temperature to rise, producing a corresponding degree of superheating, recorded by the thermometers. As observed through the windows, the cold walls of the interior of the drum were almost immediately covered with moisture, which gathered into drops and collected at the bottom. As the temperature increased this water was gradually evaporated, while the walls became dry. The nozzle through which the steam flowed gave practically an adiabatic expansion of the steam before it reached the reversing bucket, and it was possible to see clearly the formation of drops of water in the expanding steam before the rise in temperature took place, and also to determine the absence of entrained water at the beginning of the expansion. The experiments were made principally upon steam of low pressure, the superheat ranging from 24 to 44 degrees C. above the saturation temperature.

For the details of the experiments and the tabulated results the reader must be referred to the original paper, but the conclusions may be given here. It was definitely determined that for each set of steam conditions, each diameter of pipe, and every kind of pipe, there exists a degree of superheat above which no water can exist in the liquid state, either in the mass of the steam, or as a film upon the metallic surfaces. If steam is to be conducted through pipes or mains without the formation of water it is therefore evident that such an excess in temperature over that of saturation must be maintained, otherwise condensation will occur, both in the mains and in any separating device which may be employed. The question of the drop in temperature during transmission, due to distance, velocity of flow, etc., must be taken into account, in order that the critical minimum degree of superheat below which liquefaction may occur shall not be passed, is an important one, and these points should be fully considered in arranging a power system for superheated steam, this preliminary degree of superheat being included in the total, but not counted on as available in connection with the conversion of energy in the cylinder.

Herr Richter gives a number of tables arranged from the experiments of Dr. Berner upon the losses in the transmission of superheated steam through mains, and from these it is possible to deduce formulas enabling the degree of superheat to maintain dry steam to be determined for practical installations. Above all these researches show the desirability of arranging close proximity for boiler and engine in plants using superheating, removing as much of the transmission loss as possible by reducing the distance, and this point may go far toward accounting for the high efficiency which has been attained with superheating in semi-portable equipments in which the engine is attached to the boiler and the steam passes directly to the cylinder without any exposed main.

WORKSHOP ILLUMINATION.

PRACTICAL CONSIDERATIONS GOVERNING THE EFFICIENT LIGHTING OF WORKSHOPS BY ARTIFICIAL APPLIANCES.

A. E. A. Edwards—Coventry Engineering Society.

ARTIFICIAL lighting is at best but an imperfect substitute for daylight in the machine shop, but since shops must be artificially lighted during the winter season, or when night work is required, it is most essential that the best lighting methods be employed, and the loss of illumination reduced to a minimum. It must be remembered that the efficiency of workmen is always lower with artificial lighting than with daylight, while the rate of wages is usually higher, so that it is the worst kind of economy to attempt to save money at the expense of light.

In a paper presented before the Coventry Engineering Society by Mr. A. E. A. Edwards, this subject of workshop illumination was discussed in a very practical manner, and some abstract of his remarks will be found of value and interest.

In the first place the importance of providing good reflecting surfaces to the walls and ceiling is emphasised. It is computed that with a room of which the interior is painted white, a 20 candle-power lamp will give the same illumination as a 100 candle-power lamp in a room with black surfaces. White paint, or even whitewash, is not expensive, but, so far as adding to the returns from investments in lighting are concerned, they are most efficient. In the same line of improvement comes the obvious one of painting machinery a light color, a light gray, or lead color giving a much better distribution of the available light than if any dark color is employed.

It must not be assumed that the color of the walls or of the machines is in tself enough to insure the proper lighting of any particular detail, but it will add greatly to the general illumination of the room. A brilliant lighting at any definite point, as upon a vise or lathe, can only be obtained by having a light near that point; but in such cases the use of a suitable reflector of paper or other material will enable a resultant illumination of easily 50 per cent more than would otherwise be obtained. Experiment has shown that a mirror reflects 95 per cent of the light which falls upon it, while white paper reflects 80 per cent, so that a very efficient reflector of any desired shape may readily be made of a sheet of clean white paper or cardboard.

In this connection Mr. Edwards makes some valuable observations about the obstruction to light caused by shades of various materials. Thus an ordinarily plain glass window will obstruct from 7 to 10 per cent of the light falling upon it; ribbed glass will obstruct 15 to 30 per cent, while the loss with opaline glass is 15 to 40 per cent, and with ground glass, 30 to 60 per cent. It must be remembered, however, that losses fully as great as these may easily occur with clear glass if the windows are allowed to become dirty, and the same is true of globes and shades for artificial lights. Although at least 15 per cent of the light is absorbed by an opal globe, it is better to use the globe than the naked light, because the light is diffused from the whole surface of the globe, and sharp shadows are thus avoided.

With regard to the height of lights, it must be remembered that one candle at 1 ft. distance will illuminate a surface as well as four candles at 2 ft., or 16 candles at 4 ft. Therefore lamps should not be placed higher than necessary, or the illuminating effect is lost in a great measure. If there is no other controlling circumstance, except to get a good general illumination on the floor or tables of a room, the distance between the lights should equal their height above the surface to be illuminated.

Now as to gas burners — simple little things at 1d. each, and yet much thought and care has been expended on their design and construction. The light we get from a burner does not depend altogether on the amount of gas that is passed through it. For instance, if we take two gas jets burning in an ordinary manner, and place them side by side, so that the two flames intermingle, the candle-power of the resultant flame is much greater than the candle-power of the two flames burning separately. In an ordinary union-jet burner there are two holes fairly close together. After use these holes alter in size and shape, and the lighting power of the jet rapidly deteriorates; these burners usually give 1¼ to 1½ candle-power per cubic foot of gas used per hour, while a good steatite burner gives 2½ candle-power per cubic foot. The inference to be drawn is that as soon as the shape of the gas flame has become altered you may know that you are using that burner at a low efficiency, and it will pay you to throw the burner away and to put on another. Always start the winter with new burners all round, and if an old No. 5 burner gives light enough, put on a new No. 4 instead. This will give as good a light, and save about 1½ ft. of gas per hour.

The pressure of gas will affect the consumption and candle-power per burner to a very great extent. Governor burners, which can be bought for about 6d. each, are often more serviceable than the expensive apparatus fixed in the main supply pipe, which at best will only serve for one or two floors, as the pressure of gas increases 1-10 in. for each 10 ft. rise.

Incandescent gas lighting is the most economical system of lighting we have at present, where there is very little vibration and the lights are fixed.

Incandescent gas burners rapidly accumulate dust, and should be thoroughly cleaned every 200 or 300 lighting hours, or oftener in very dusty places. Such lights, when properly installed and well cared for are very satisfactory, but they should not be used on hinged brackets, or anywhere where there is continual vibration. Mr. Edwards gives the results of tests of incandescent mantle burners with Dowson producer gas, showing an illumination of 8 to 10 candle-power with a consumption of 4.5 to 4.8 cubic feet of gas. With a sufficient pressure and volume of gas there is no good reason why producer gas should not be used to great advantage in this manner, without any carburetting or other special preparation.

Incandescent electric lamps are very badly used by many men who have not studied the relation between the voltage, the efficiency, and the life of the lamp. A high efficiency lamp means that the energy consumed, when the lamp is new, is from 2½ watts to 3½ watts per candle-power, instead of 3.75 to 4 watts per candle-power, the ordinary consumption. High efficiency is attained by making the carbon filament hotter than usual. This causes particles of carbon to fly off the filament on to the interior of the globe, and the lamps become blackened, and the candle-power is greatly decreased. The economical life of the lamp is, therefore, very much reduced. By economical life of a lamp is meant the hours a lamp will run before its candle-power is reduced 25 per cent.

The same thing occurs if the voltage is increased beyond that for which the lamp is constructed.

After the first few hours of over pressure the candle-power of the lamp rapidly diminishes, although the same quantity of current is used, and the result is that the workman is short of light, or else could do with a lower candle-power lamp to begin with, if it would maintain its efficiency for a longer period.

One object in specially mentioning this point about lamps is to give a warning against buying and using these so-called very high efficiency lamps.

Some electrical supply companies supply current at from 8 to 10 per cent over the normal pressure, and the result is that the lamps fed from their mains must either be replaced after about 200 hours' lighting, or they become so black as to be very seriously inefficient. The net result to the consumer is that he has 10 per cent more current forced through his lamps than he wishes to have, and for which he has to pay, and the candle-power of his lamps is no more than it would be with normal pressure, except for the first few hours the lamps are in use. The lamp renewals through breakage are also very excessive.

In the case of gas burners, as with incandescent electric lamps, it does not pay to run them until they break. The average life of a good lamp will be 1,000 hours, if they are not run over pressure, and at the end of that time it will certainly pay to break the lamp and replace it.

Arc lighting is one of the cheapest forms of artificial light for use in large buildings where a general light is required.

Arc lamps, like all other sources of light, should be so placed that the eye does not catch sight of the lamp while the workman is engaged in his occupation, although, on the other hand, they must not be "skied," for reasons I have given before.. The advantage usually claimed for the enclosed or double globe arc lamps over those of the ordinary type is that they require carboning only about once in 200 hours, although, on the other hand, the globes and rods should be cleaned about every 50 hours. The loss in lighting power through having a double globe is about twenty per cent more than with the single globe. The principal advantages of these lamps are that they can be run separately on a 100 or 110 volt circuit, whereas the ordinary arc lamps are obliged to be fixed two in series on a 100 volt circuit; and also that the insurance companies, in certain classes of risks, will not increase their rate for enclosed lamps, as they would do for ordinary arc lamps.

Inverted arc lamps are admirable where a soft, shadowless, pure white light is necessary, and are specially valuable if the ceilings are low; but with this style of lamp a white ceiling, or blinds over the lights, are quite necessary.

MODERN LOCOMOTIVE PRACTICE.

THE ACTUAL EFFICIENCY OF THE MODERN LOCOMOTIVE AND THE DEVELOPMENT OF THE LARGE LOCOMOTIVE.

W. P. Evans, G. M. Basford—Pacific Coast Club.

At a recent meeting of the Pacific Coast Railway Club there was presented two papers of much importance relating to an interesting department of railway engineering; namely, to the modern locomotive and its efficiency.

The paper by Mr. W. P. Evans treated of the actual efficiency of a modern locomotive as represented by work actually performed, and hence it comes as a valuable pendant to the work of the testing plant of the Pennsylvania Railroad Company, the report of which was reviewed in these pages last month. A comparison of the economic performance of the modern large locomotive with the best machines of twenty years previous enables the works of the St. Louis testing plant to be compared itself with the most severe of all tests, the everyday work and demands of actual railway service.

Mr. Basford devotes his paper almost entirely to the increase in weight and dimensions of the steam locomotive, and forms an excellent supplement to the paper of Mr. Muhlfeld upon large locomotives, and that of Mr. Churchward, upon large locomotive boilers, lately reviewed in these columns. It is most interesting to note that even in the midst of active work and discussion as to the possible replacement of the steam locomotive by some form of electric traction there has appeared a renewed interest in the performance of the steam machine, including both its efficiency and its capacity.

Mr. Evans shows that while little or no improvement in the steam consumption of the single expansion engine has been made over the locomtives of twenty years ago, the use of compounding has resulted in an economy, with freight engines, of about 17 per cent. Superheating, however, has proved even more effective than compounding in the reduction of the water rate, tests upon the coal consumption per 1,000 ton miles on the Canadian Pacific Railroad showing gains of 22 to 26 per cent, due to superheating. The actual first cost of locomotives has naturally increased with the increase in dimensions, but the cost per pound has fallen, on an average, from $0.087 per pound in 1885 to $0.082 per pound in 1905.

Mr. Evans treats the important subject of depreciation in an interesting manner, and in this respect his paper may be used to advantage in considering other kinds of machinery besides locomotives.

"As soon as the engine goes into service, its value takes a sudden drop due to the fact that it then becomes a second-hand machine. After this its depreciation is gradual until the cost of repairs and maintenance equals the service which can be obtained for it. Under average conditions prevailing in this country this occurs after a service of about twenty years when the curve of depreciation runs parallel to the base line.

It may be discussed systematically by dividing it into several principal headings.

Considering the original cost of the locomotive and its present value, to the cost charged by the builder should be added the freight charge for delivery and the cost of breaking in the locomotive. The value of locomotives which have been in service a number of years, but which are in good working order, may be obtained approximately by obtaining the net weight of the locomotive proper, without tender, and without water in the boiler, and multiplying this weight by seven for the value in cents.

"Depreciation must have some relation to the estimated life, but it is not necessarily as constant as is often assumed. The common rule is to divide the original cost by the estimated life in years to find the yearly depreciation. A more rational method is based on the fact that after certain periods of service locomotives depreciate more rapidly. When this is taken account of it is suggested that for the first five years the full second-hand value of the locomotive may be taken; for the second five years 85 per cent of this second-hand value; for the third five years 70 per cent; and after 15 years 50 per cent of the second-hand value; after 20 years 25 per cent of the first cost."

Another method suggested is to treat the value of the locomotive as an amount of capital to be redeemed by an annuity in a given number of years, and the annual payments determined from the actuarial tables on this assumption will then be the yearly depreciation to be deducted from the value of the engine.

As a matter of fact the depreciation of a locomotive depends more upon the service and use of the locomotive than upon the machine itself. The older engines were used more carefully and rendered less service than now, so that the increased depreciation charges really represent a part of the price paid for the increased capacity.

The real thing in which the railroad man is interested is the hauling capacity and the cost per ton mile and train mile. The increase in tractive capacity is given in tabulated form by Mr. Evans the average results of which are here given in condensed shape:

"The tractive effort of passenger engines has increased from 15,250 to 23,740, or 55.6 per cent; of freight engines from 25,720 to 46,600, or 81.2 per cent. These figures show an enormous increase in size of locomotives in use to-day over those employed twenty years ago. During this time, however, but few railroads have seen any material improvement in the roundhouse facilities or shop equipment, and it is a grand tribute to the mechanical officers of railroads that repairs have been kept as low as they have.

"The table of actual train loads shows what has been done with the power available on the roads, part of it being light power built some time ago, and part the modern heavy power. The train loads have actually increased from 229 to 385 tons, or 68 per cent.

"With an increase of tractive effort of 55.6 and 81.2 per cent for passenger and freight engines in ten years, the train loads actually hauled have increased 68 per cent. These figures agree surprisingly well, which is a coincidence, because there are a great many considerations other than engine power which go to make up the average tonnage of trains hauled for a year."

The cost per ton mile depends to a large extent upon the train load. From 1895 to 1900 the increase in train loads brought the ton mile cost down from about 70 cent to 0.47 cent, while little or no reduction has been effected since. The lowest cost goes with the heaviest train, which itself accounts for the great increase in the weight of trains. During the past ten years the average train load has nearly doubled, subject, of course to local conditions of grades and operative conditions.

Mr. Basford shows in a most interesting manner the rapid increase in locomotive dimensions and weights. In 1888 Mr. M. N. Forney predicted that by 1918 the passenger locomotive would reach a weight of 200,000 pounds, while, as a matter of fact the weight passed 230,000 pounds in 1905. In 1900 Mr. Forsyth predicted that in 1905 freight locomotives of 311,000 pounds would be built, and this figure was passed by the construction of the Mallet articulated locomotive of 334,000 pounds weight last year.

"This rapid advance in weight and power is too general to be anything but a principle in American locomotive practice, and it is a principle which compels the most careful consideration and deepest thought of those who decide questions of design, as well as those who bear the responsibilities for other improvements in equipment and maintenance facilities, in the advance of which the locomotive now stands.

"Because of the increasing weights of cars and trains, we must have large and powerful locomotives. This fact seems to be sufficiently demonstrated. Whether they are in every respect popular or not, they constitute an economic necessity in present day conditions. It seems to be altogether improbable that there can ever be a pause in the advancement to more powerful units, and as long as the country supplies such increasing quantities of commodities to be moved, we can not go backward in the power to move them. There has been no backward step and no halting in the growth of the ocean liner, and for the same reason there can not be in the locomotive. Economical operation requires the heavy load. As the channels of the harbors must be dredged to depths of forty feet to pass great ships, and as the docks must be enlarged to receive them, so must the facilities for dealing with the large locomotive be provided. Having the large locomotive, we have the problem of designing, of operating, and of maintaining, to render its service satisfactory. No questions presented in previous years of locomotive development have ever been as important or as difficult as those now before us.

"The question is not, Shall the next order of locomotives be big ones? They *must* be big ones. That is settled beyond argument The question is, How shall they be built?"

Mr. Basford brings out a very important point, and one which has not been given sufficient consideration, namely, that the best results cannot be expected by increaseing the size of the locomotive without making a corresponding improvement in the conditions under which it is used.

"In estimating the real value of the very powerful locomotive of the present time, as compared with the locomotives of twenty or more years ago, much beside the locomotive itself must be considered. In the foregoing question presented for discussion, the locomotive only is mentioned, and this is but one phase of the very great change which the railroad problem has undergone, and is undergoing. It seems perfectly fair to state, and perfectly easy to maintain, that the increased cost of operating large locomotives—where there really is an increase—is largely due to operating conditions and to operating facilities which have not always grown proportionately. For example, the consumption of fuel while large locomotives are standing on sidetracks is becoming an item of importance, yet this is as nothing compared with the cost of other losses of time on sidings. Not infrequently freight locomotives average only five miles an hour in speed when actually on the road. Not infrequently the speed between stations will be up to the extreme limit of the capacity of the locomotive, and this will be followed by a half hour or an hour spent on the sidetrack. Even the four or six pounds of coal per square foot of grate area per hour necessary to keep up steam while on the siding is not a negligible quantity under present conditions."

The real question to-day is, Are other factors, which combined constitute the operation problem, advancing rapidly enough to provide the opportunity for securing the most advantageous results from the large locomotives?

ELECTRICITY IN MINING OPERATIONS.

THE INFLUENCE OF ELECTRIC POWER UPON ECONOMY, EFFICIENCY AND OUTPUT IN COAL MINING.

R. G. Mercer—Birmingham and District Electric Club.

IN a paper recently presented before the Birmingham and District Electric Club the question of the advantages of electrical transmission of power for mining operations, with especial reference to collieries was treated by Mr. R. G. Mercer. As the author well says, no industry calls for the transmission of power to greater distances and under more disadvantageous conditions, and no class of work exposes the machinery to rougher or more onerous usage than the mining industry. For these reasons steam, compressed air, and mechanical transmission are being rapidly superseded by electrical methods, which, besides giving increased reliability and freedom from breakdown, have been proved to be considerably more efficient and convenient, besides being less expensive in operation.

"Much has been written on the subject of electric winding, but little has been done in Great Britain with regard to the application of electricity to winding. This is probably due to the difficulty of coupling motors satisfactorily to existing drums. Steam winding engines, as at present used in this country, are among the most inefficient appliances about a colliery, owing to the large amount of power for starting and accelerating the load; the steam consumption of these engines per horse-power-hour of actual work done, in raising coal, varies from 50 lb. to 120 lb. or more in many cases. The most modern steam plant, even when fitted with automatic expansion gear and exhausting into a condenser, cannot compare with an electric winding plant from an economical point of view. The certainty and simplicity of control, and the handiness of electric winding gear, the uniform torque of the motors, which allows the flywheel effect of the winding engine to be reduced to the smallest possible amount, while a steam engine must in many cases have a greater flywheel effect, due to its reciprocating action, are strong recommendations."

The question of electric haulage in mines appears to have been settled in the affirmative by reason of the large practical success which has been attained both in the United States and elsewhere. While the cost of maintenance is less with electrical haulage than with any other method, the greatest economy appears in the question of reduced attendance. The replacement of steam haulage by electricity has in some cases enabled the output to be doubled, while the cost at the same time reduced to about one-tenth that of animal haulage.

Electric locomotives both for mine and surface haulage as at present constructed are thoroughly sound and efficient machines. In general the motors are of the steel clad enclosed railway type, the controllers have magnetic blow-outs which prevent arcing between contacts and are, together with the resistance and motor, specially designed and constructed for mining service. Standard sizes of these locomotives range from 16 H.P. to 100 H.P. or over, weighing respectively 2 and 13 tons.

The track gauge may be anything from 18in. upwards and the minimum height exclusive of trolleys, respectively, 32 in. and 36 in., so it will be noted what a very small amount of head room these locomotives require. Where rope haulage plants are already in use and where the conditions are not suitable for locomotives, the electric motor can with advantage replace the steam engine for driving the drum. When the endless rope system is employed a constant speed motor drives the drum continually in one direction. With the main and tail system two drums maye be connected to a reversing motor or to two separate motors. Where polyphase current is used it is advisable, unless a friction clutch be used, to operate the haulage gear by means of a slip-ring motor, the controllers and switches being immersed in oil of a high flash point. When a friction clutch is used, the squirrel cage motor can be used. The absence of sensitive parts is an immense advantage where motors are entrusted to the care of unskilled men and exposed to much dirt, dust or damp. The motor is as simple as a grindstone and will run continuously with no further attention than that required to fill the oil wells. It may be pulled up dead by extreme overload without injury, a thing impossible with any other type of motor; it is capable of developing a torque several times its normal full load torque and is therefore not liable to be stopped by momentary overload."

One of the earliest applications of electricity in mining operations was that of operating mining pumps. With the earlier, slow speed reciprocating pumps a double speed reduction was necessary to enable the motors to be connected. High-speed reciprocating pumps of modern design have since been designed, enabling electric motors to be attached with but a single gear reduction, the speeds of such pumps varying from 160 to 300 revolutions per minute, according to size.

"High lift turbine pumps are now being used extensively, the cost of making foundation and excavating rooms for them is less than for a reciprocating pump of similar capacity, because the turbine pumps operate at a very much higher speed (such a speed indeed that the motors have to be specially designed for running them), and consequently the pump and motor are very much more compact. There are no air vessels, there is no water-hammering in the pipes and the flow is continuous.

"The most important factor limiting the speed is the quality of the water passing through the pump; if the water is dirty and gritty the speed should be as moderate as possible, owing to the excessive wear of the internal parts of the pump if it is running at as high a speed as it can with clean water. It is impossible to fix any hard-and-fast rule about the relation of capacity to head, but generally speaking at ordinary speeds, to obtain the best results with a pump of moderate price, the number of gallons per minute should be about equal to the number of feet in total head. As an example, a pump designed to deliver 500 gallons per minute against a head of 500 ft. would give an efficiency of not less than 72 per cent, while the best efficiency possible with a pump designed to deliver 50 gallons against the same head would only be about 60 per cent. Where the conditions are such as demand variation in head, this can be easily obtained within certain limits by adopting a multistage turbine, arranged so that one or more of the impellers can be cut out, either by removing the impellers from the pump or by the use of a special bye-pass; should the quantity only require to be varied the result can generally be obtained with a little loss of efficiency by throttling the discharge. The very best type of motor for coupling up for turbine pumps is undoubtedly the squirrel cage motor, whose starting current is not excessive and will probably not exceed full load current."

We have already reviewed in these columns the experiments which have been conducted in Germany and Belgium upon the posibility of the ignition of mine gases by the sparks from dynamos and motors. This feature of the subject of electric driving in mines is one which is attracting much attention at present, and there is little doubt that the improvements which are continually being made in this respect will remove the restrictions which at first were found necessary.

In general it appears that the application of electric power in collieries means not only a large reduction in the cost of the coal mined, but also an increased output and all-round better working conditions. A tabulation of the costs of mining power for various operations under the old system and the new in several collieries shows that the annual saving in consequence of using electric plant is so large as to enable the plant to pay for itself in a few years. There are other economies which are less easily reduced to definite figures than the fuel and labor items, and among these may be mentioned the possibility of centralising the power generating plant and most of the skilled attendants within the walls of a single building. This is of special advantage where several shafts are worked under the same management. A large reduction is effected in the cost of maintenance and repairs as compared with more antiquated machinery, and again, a safe, efficient, and economical means of lighting the mine is provided, this being a contingent advantage of the greatest value.

THE COMMERCIAL ENGINEER.

COMMERCIAL REQUIREMENTS IN PRACTICAL ENGINEERING WORK AND THEIR RELATION TO TECHNICAL EDUCATION.

W. Bardill—Birmingham Association of Mechanical Engineers.

SO much has been written and said of late about technical education that it might be thought that some tangible results were about due. Such results as have been attained are not wholly encouraging, and thoughtful men are beginning to wonder if the methods employed are altogether those best adapted to the purpose. The status of affairs in Great Britain is well set forth in a paper presented before the Birmingham Association of Mechanical Engineers by Mr. W. Bardill, from which we make some abstracts.

"When one pauses to think of the number of acts of Parliament that have been passed, the discussions on the education estimates, the number of codes that have been issued, the number and amount of rates that have been paid, the number of schools that have been built, the salaries that have been received, and the grumbling that has been indulged in, one is led to expect something in the shape of results. Yet, on the other hand, it is an absolute fact, which many can no doubt verify, that it is one the rarest events in one's business experience to secure a youth fresh from school who can address even an envelope so as to be decipherable at first glance, whilst for spelling and arithmetic, these are things which had better be left without comment. You question such a youth and ask him what he learned at school. He will tell you, perhaps, physiography, chemistry, a little French and German, and, perhaps, even Spanish. There is no wish on the part of any sensible person to decry this knowledge, but surely it is of much greater importance that a boy, on leaving school, should be able first to speak, and write in a legible hand the language of his own country, and also to be familiar with the elementary rules and tables of arithmetic which enter into the daily routine of common every-day life.

"This is a serious matter for the nation. In the few years betwixt 14 and 21 years of age a tragedy may be perpetrated, inasmuch as a youth has either made use of his knowledge and gone forth to hold his own in life's battle, or he has gone to join the ever-swelling army in this country of the unfit, the inefficient, or the unemployed.

"It is at this point that we will take him up and examine his prospects for promotion in the engineering profession. There is probably no question more troublesome to an average parent than to know what to do with our boys. It too often happens that because he has saved his pocket money and has purchased a model engine, or has taken the mangle to pieces, or the sewing machine, then the question is settled for ever — he must be an engineer. The course now open, according to the means of the parents, is clear, according to the accepted ideas. If wealthy, they will be advised to allow the boy to remain at the grammar school till say, he is 15, then to take a three-year's course at a technical school, by which time he is 18, then to take another three years as a premium apprentice at an established engineering works. This is an excellent course for those who can afford it, although amongst specialists there is much disputing whether the college course should precede or follow the practical training of the shop. So far as can be seen from actual cases that pass under one's own observation, this point is not worth much discussion, as neither the one nor the other, with the usual exceptions to every rule, count for much".

It has been said that the engineering profession is overcrowded, that technically trained men are not what the employers want, that the product of the present educational institution is worse than useless in the workshop, and that his training has to be begun all over again before he is really worth his wages. That there is some degree of truth in these statements must be admitted, but such views cannot be wholly accepted.

"It might be put forward with a great degree of truth that a good deal too much money was being spent in such schools for the amount of good they were doing, *i. e.,* that their mechanical efficiency was low. It might also be put forward with an even greater degree of truth than in the first instance, that the teaching staff of some of the technical schools leaves something to be desired, especially so as the staff often consists far too much of the schoolmaster than the practical engineer or electrician, From considerable experience of those who have gone through such schools, an impression has grown that in many cases the professor or tutor has laboured most to demonstrate to his pupils what a wonderfully clever man he himself was, rather than adapt himself to his pupils and give practical information. This is quite true, and in many cases it accounts for the many lapses in attendance at the various evening classes, and for the indifference to a large extent of the ordinary day student of the average technical school. The lectures are often enough right above the head of the average student, and they are often accompanied by an exhibition of intellectual fireworks which blinds the poor student.

" There is, of course, the exception of the odd youth who is anxious, and who, not satisfied with receiving those blinding flashes of truth so suddenly, buttonholes the professor on the quiet, before or after the lecture, and asks questions which enable the professor to speak quietly from his own natural good-hearted self, and the youth, by having thus had the current switched on gently, perceives by-and-by a faint glimmer of light, and he follows it and chases the professor till he really does understand what it all means. That youth is on the way to being a manager very quickly.

" Generally speaking, there is too much of the school, and too little of the shop in the technical schools. By that it is not meant that the schools do not possess large enough workshops or sufficient machine tools. On the contrary, there are too many of these, and what good is to be gained by teaching a draper's assistant to use a lathe, or a hairdresser's assistant to plane wood, is hard to say. The place to learn a trade is the shop itself, but the place to learn the science which lies behind the handicraft is the technical school.

What is meant is, that whilst we would not go the length of stating, as the proprietor of one of the largest and best-known engineering works in Great Britain once said, that 'professors were generally men who had been an absolute failure in business life, and were obliged to take to lecturing for a living,' yet it is a fact that both universities and technical schools have far too few successful engineers and business men amongst them."

There is no doubt that there is much room for improvement in the relation between the technical school and the shop, but that fact furnishes the best possible reason for pushing ahead in every way possible to improve the efficiency of the institutions to which it is realized that we must look for the material for the trained engineers of the immediate future. Closer relations should be established between the scientific school and the shop. Greater care taken to demand the appointment of professors and teachers who have had practical experience with the great manufacturing industries of the world, and above all ample opportunities should be given to the professors to show what is in them by permitting them to devote a reasonable amount of their time to outside practice. The American practice of having lectures delivered before students by men who are themselves in charge of great manufacturing and engineering enterprises has been found of value in creating relations of value between the technical school and the productive workshop, and unless such relations can be created and maintained much of the work of the school will be vain.

"The employers of labour in Great Britain are being gradually forced to recognise that their future hopes are contained only in 'tariff reform' but in that one word which means so much, "efficiency." Therefore, at whatever risk and at whatever cost, the employer is or will be forced to make up his mind that whatever is inefficient, no matter how it is endeared to him by ancient associations or happy recollections, must go, and whether it be inefficient staff, inefficient workmen, inefficient power, or inefficient plant, down they must come, and if he be wise, to that plaintive song 'Woodman spare that tree,' he must turn a deaf ear, and with the energy of a Gladstone he must ply the axe till those forces which now hinder his development are severed for ever. To fill the gaps thus made his only chance is to transplant young shoots, and whether they be grown in the technical school or in the employers' own forcing house, it matters not; so long as they are full of sap and energy he will be well repaid for his sacrifice."

ELECTRIC DRIVING OF MACHINERY.

PRACTICAL NOTES UPON THE INSTALLATION OF ELECTRIC MOTORS FOR OPERATING TOOLS AND MACHINERY OF VARIOUS CLASSES.

W. J. Belsey—Institution of Electrical Engineers.

AT the present time the discussion upon the employment of electricity as a means of transmitting and applying power is no longer confined to the comparison of advantages between electric driving and other methods; the advantages of electricity are practically admitted and the real question is not: Shall we use electricity? but rather: How shall we use electricity? It is to furnish the answer, or rather the answers to this latter question that we abstract a paper presented before the Dublin local section of the Institution of Electrical Engineers by Mr. W. J. Belsey, giving notes upon the subject of driving machinery of various kinds by means of electric motors.

A problem which almost invariably confronts us in the laying out of an electrical drive is to determine whether the machines should be driven individually or in groups, and unless one has a most intimate knowledge of the working conditions which obtain, it is most difficult to say which is the best. As a general rule, individual driving is about fifty to sixty-five per cent greater in the first cost than group driving. The advantages of individual driving are well marked, in that each machine is an independent unit and can be run without respect to the other machinery. The liability to break down is considerably lessened, and full advantage can be taken of the stops or intermittent working of the machine, current being only taken when the machine is in use and only in proportion to the work done. The advantage of a group drive is principally in the low first cost. In the majority of cases, however, the problem resolves itself into a compromise, the larger machines being driven by individual motors and the smaller ones grouped together in small groups driven from short lines of shafting. The question of a proper grouping is one which merits very serious consideration, as on it very often depends the financial success of an installation.

Mr. Belsey takes up the operation of factories of different kinds, beginning with the textile industries. Considering first the operation of spinning, the primary consideration is that of the maintenance of a predetermined constant speed, in order that there may be uniformity in the product and a minimum of broken ends. For these reasons it will be evident that the induction motor is best suited for the operation of spinning frames, for its speed with a given load is constant with respect to the speed of the prime mover, and as the load on spinning frames varies but slightly whether empty or full, it may be said that if driven by an induction motor the speed of the frame will be constant with respect to the speed of the prime mover. The speed of a shunt-wound direct-current motor is not by any means solely dependent upon the speed of the prime mover, for it varies, depending upon whether the motor is hot or cold, and the difference in speed with a continuous-current motor, cold and hot, is generally about five to ten per cent, say eight per cent as a fair average, and it takes from two to four hours (depending on the size) for a motor, starting cold, to reach its maximum speed. This means loss in production. Of course, these difficulties could be overcome if we fixed shunt regulators on to the motors and generators, but if the mill manager did this he would be taking the production out of the hands of the management and giving it to the operators, which, to say the least, would be unwise, and a condition which no mill manager would consider for a moment. Again, the atmosphere of a spinning mill is invariably charged with fine lint dust and fibre, which has a most deleterious effect on the commutators of direct-current machines, and this in itself is sufficient to preclude the adoption of direct-current machines for this class of work. Also, as every available square foot of floor space is occupied by producing machinery, the motor is generally located either on a platform hung from the ceiling, or is bolted direct to the ceiling in an inverted position.

A group system of driving is generally adopted for spinning mills. The motor is usually of a large capacity, ranging from seventy-five horse-power to 150 horse-power, and is direct-coupled to the line of shafting, from which are driven a number of machines by means of belts. The overall efficiency of this method is equal to that of the individual drive, notwithstanding the use of belt transmission to the individual machines. This is due to the much higher efficiency of the larger motors, as compared with the efficiency of the smaller motor used on the individual drive system. A disadvantage of the group system, however, is that it is practically impossible to vary the speed of the individual frames while they are in operation. The same remarks as to the suitability of alternating-current-induction motors apply in a somewhat lesser degree to the other operations in a spinning mill, such as carding, breaking, hackling, spreading, etc.

In the other departments of textile work the conditions vary. For operating looms the maintenance of a maximum uniform speed is desirable and here again the induction motor is suitable. The operation of bleaching, finishing, and printing, on the contrary demand a convenient and economical speed control, thus indicating the use of direct-current motors, and since the machines demand from twelve to fifty horse-power, independent driving is applicable.

Coming to the subject of machine shops and foundries, Mr. Belsey believes that the continuous-current motor is generally best adapted for machine-shop service, and thinks that in general it pays to use individual driving for any machine requiring more than five horse power.

The author gives a series of tables indicating in a general way the power required by machine tools of different kinds, but unless the speed and the nature of the work are known, such estimates can be only of the most general character. As has been shown elsewhere, a fair criterion of the amount of power required is that of the weight of material removed in a given time, and in this case also, the condition and character of the cutting tool exercises an important influence upon the power consumption.

In the foundry the induction motor is to be recommended, since there is no demand for a variable speed, while the dusty condition of the surroundings renders it very desirable to dispense with the commutator.

An important department of work to which electric driving may be applied to advantage is that of working upon plate and structural steel. This includes both shipbuilding and general structural work, and the conditions demand somewhat various requirements to be met.

Undoubtedly for punching and shearing machines, induction motors are the best suited, principally on account of their very robust construction and also because an induction motor can exert a much higher torque than a direct-current motor when suddenly required—as in the case of the actual moment of shearing and punching—without an appreciable variation of speed. The speed of punching varies from about twenty-eight strokes per minute in the larger punches for one and one-half-inch-thick plates to about forty strokes per minute in the smaller ones, three-quarter inch plates. It is not generally considered good practice to exceed these speeds, as, if higher are used, the squad just misses a stroke, and therefore reduces the actual speed of punching by half. If direct-current machines are used, they should be compound-wound. Angle cutters and beam punches all have the same charcteristics as the above.

For plate binding rolls and mast rolls the motors should have the same characteristics as a railway or crane motor—*i. e.,* they should be series-wound and be capable of exerting a high torque when required. Plate roll motors are generally fitted with a brake attachment for convenience of adjusting the rolls. Although the series motor is undoubtedly the best suited for this class of machine, yet induction motors have been used with very considerable success for driving them, and on the north-east coast nearly all machines are driven by three-phase motors.

For the smaller machines used in structural steel works the same conditions apply as in the general machine shop, and direct-current machines are applicable. Individual motors are usually the best owing to the freedom given in the placing of the tools where they can be worked to the best advantage.

Mr. Belsey discusses at some length the application of electric driving to rolling mills, with especial reference to the sudden and heavy shocks for which provision must be made. It is evident in such service that some provision must be made for storing and giving out energy, and this may be done either by using a battery of accumulators or by employing a buffer machine for storing the energy in a heavy fly wheel. The system advocated by Mr. Belsey includes the use of a variable-speed dynamo, upon the shaft of which is fitted a heavy fly wheel, this machine acting as a motor or a generator according as it is receiving or giving out power.

THE STEAM ACCUMULATOR.

PRACTICAL EXPERIENCE IN THE USE OF INTERMITTENT DISCHARGES OF EXHAUST STEAM IN THE LOW-PRESSURE TURBINE.

A. Heller—Verein Deutscher Ingenieure.

WE have already referred in the pages of this magazine to the remarkable experiments of Rateau in connection with the development of the low-pressure steam turbine, especially in connection with the utilization of exhaust steam from large reciprocating engines. It is well known that in many cases it is impracticable to apply well-established principles of economical working to reciprocating engines owing to the controlling conditions under which they must be operated. Thus in the case of winding engines for deep mine hoisting, the irregularity in the load and speed, and the necessity for keeping the control of the machine wholly in the hands of the attendant, render it practically impossible to introduce the methods of automatic cut-off and multiple expansion so necessary to maximum steam economy. Similar conditions exist in the case of rolling-mill engines, the intermittent nature of the load in this case giving rise to very marked fluctuations of the pressure and volume of exhaust discharge.

In an article by Herr A. Heller in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* there is given an interesting account of the results which have been attained in Germany with the steam accumulator and the low-pressure steam turbine, this supplementing in a very effective manner the work which has been done in similar directions in France.

The principle of the steam accumulator is very simple, consisting in the provision of a sufficient mass of some heat absorbing material, such as iron, or water, this receiving the heat of the exhaust steam when it is in excess of the average and giving it out when the temperature falls, forming what may, by analogy, be termed a sort of thermal fly-wheel. There is thus a vessel which receives the intermittent discharges of exhaust steam from the reciprocating engine and gives out a flow of steam of practically uniform pressure, suitable for the operation of a turbine especially designed for the purpose.

The field for such an appliance will be realized when it is understood that there are now in operation a large number of reciprocating engines discharging their exhaust into the atmosphere, and necessarily operating in such a wasteful manner as to cause steam consumption rates of 80 to 100 pounds per horse power per hour. It is well known that such conditions are most undesirable, but, as in the case of winding engines, or of rolling-mill engines, the demands of the service preclude the introduction of methods generally in use to effect better economy. In such plants the steam accumulator appears to have a legitimate field for its operation.

The plants installed by Rateau at the Bruay mines (Pas de Calais) and at the Reunion mines in Spain, have already been described in the issue of this magazine for October, 1903. At the Düsseldorf exposition the system was displayed by the German builders, Messrs. Balcke & Co., of Bochum, and this firm has recently installed the method in the Poensgen Iron Works, where it has now been in operation for about a year.

The accumulator at Poensgen receives the exhaust steam from a set of reversing plate rolls, several steam hammers, and from the air and circulating pumps for the central condensing plant, the total amounting 8,000 to 10,000 kilogrammes of steam per hour.

The general arrangement of the plant is similar to that of the mines at Bruay. The exhaust steam from the various engines, and other cylinders is delivered to the accumulator, this being a cylindrical vessel 8 metres in height and 4 metres in diameter, containing a series of cast iron buckets, or boxes in which the water of condensation accumulates whenever the temperature falls below the average and from which it evaporates into steam when the temperature rises. The exhaust steam enters this vessel from below, and the passages are so arranged that it comes in contact with all parts of the chamber and the water boxes, and passes out at the top of the turbine. The metal and the water become heated to the average temperature of the exhaust steam, and the processes of heat absorption and return go on continually in the interior, with the result that the discharge of steam at the outlet is almost uniform, regardless of the irregularities in the delivery at the inlet. Thus, the pressure of the exhaust steam delivered to the accumulator did not vary more than about 0.1 atmosphere. The low-pressure turbine, of the Rateau type, directly connected to two direct-current dynamos, delivered power varying according to demand from 100 to 400 kilowatts, running steadily, either in parallel or in series, according to the desired voltage, and deriving its power from steam formerly entirely thrown to waste.

Herr Heller gives reproductions of diagrams from pressure recorders to show the uniformity in steam pressure maintained in the accumulator, notwithstanding the irregularity in the sources of supply, and also gives details of the pressure regulating valves used in the connections of the apparatus.

Illustrations are also given of later types of accumulators, in which the heat absorption is effected wholly by a mass of water contained in a tank, the exhaust steam circulating through flues in the water, the variations in admission pressure being equalized by the varying rate of evaporation of the water in the tank so as to maintain practical uniformity in the discharge pressure to the turbine.

In nearly every case it is found desirable to use the power obtained from the exhaust steam to generate electric current, for which numerous uses can be found about mining plants or in rolling mills. There are numerous applications for electric motors in both departments of work, while electric lighting is always available, and when such applications of energy can be found there is every reason to install a simple mechanism for utilising the waste power at present escaping in the exhaust steam.

It is a matter of interest to note that the low-pressure steam turbine, exhausting into a vacuum, is a machine of excellent efficiency, practically as good as that of the high-pressure turbine, while the efficiency of a reciprocating engine at such pressures is very low. With the use of the steam accumulator it is practically possible to arrange a compound set in which the high-pressure portion consists of all the irregular running high-pressure machinery about the place, including winding engines, hammers, pumps, and other engines in which the conditions require the admission of high-pressure steam during the larger part of the stroke, the combined exhaust of the whole lot being delivered to an accumulator from which issues a smooth, continuous flow of steam to a turbine of high efficiency, producing electric current for lighting, auxiliary power, and all the manifold service of which it is available. without the consumption of an additional pound of fuel.

There has been some doubt as to the correctness of the statement as to the high economic performance of the steam turbine, using steam at pressures but slightly above that of the atmosphere, but M. Rateau seems to have demonstrated this fact beyond doubt by tests upon actual installations. Thus, tests of a 300 horse power low-pressure steam turbine of the Rateau type at the Bruay mines with steam pressures ranging from 0.845 to 1.034 atmospheres absolute the steam consumption ranging between 17 to 18 kilogrammes per horse power per hour. Even when the load was thrown off, and the steam pressure dropped to 0.659 atmosphere, the steam consumption was only about 19 kilogrammes per horse power per hour. Of course it is not practicable to obtain such high economical performances at these low pressures as at pressures of 10 to 12 atmospheres absolute. Thus, with an initial pressure of 11 atmospheres absolute, or about 150 pounds per square inch, the Rateau steam turbine at Penarroya showed a steam consumption of only 6.74 kilogrammes per horse power per hour, developing 641 horse power, with a vacuum of 0.128 kilogrammes per square centimetre absolute or 1.82 pounds per square inch.

In installations in which the steam accumulator is used in connection with the exhaust steam from winding or rolling-mill engines for the supply of electric current for lighting or similar service, it is necessary to install also an auxiliary machine to be used with live steam direct from the boiler in case the main engines are stopped for any reason.

ELECTRIC LOCOMOTIVES FOR THE SIMPLON TUNNEL.

DETAILS OF THE ELECTRIC TRACTION EQUIPMENT OF THE SWISS FEDERAL RAILWAY SYSTEM IN THE SIMPLON TUNNEL.

S. Herzog—Le Génie Civil.

THERE is little doubt that the strongest influence in leading the operators of main line railways to consider electric traction is its preëminent suitability for use in tunnels and subways. Even in short tunnels the presence of gas and smoke has proved a great nuisance, while in the long subways of modern great cities steam traction would be out of the question. The London underground system long suffered from the difficulties due to steam traction, and has now taken a new lease of life with the introduction of electricity. In New York the difficulties and disasters in the tunnel of the New York Central Railroad have led to the conversion, now well under way, of the system to electric traction, this extending to about thirty miles out of the city, and there is little doubt that the presence of the tunnel will prove to have been a blessing in disguise, bringing about the change from steam to electricity far earlier than would have otherwise been the case.

In regard to the great Alpine tunnels the experience has been variable. The Mont Cenis route has always been smoky and troublesome, but until lately the intervals between trains have been sufficiently great to render any change unnecessary. On the St. Gothard route there appears to have been a sufficient difference in atmospheric pressure between the two sides of the Alps to cause a fairly effective current of air through the tunnel but with the increasing frequency of trains this has been insufficient to clear the route from gases and smoke, and the Saccardo system of mechanical ventilation has been successfully introduced as described in these columns several years ago.

In the design of the Simplon tunnel as we have frequently described during the course of the work, the auxiliary tunnel, connected at frequent intervals with the main passage, affords ample opportunity for ventilation, and at first it was intended that steam locomotives should be employed in this as in the other Alpine tunnels. During the time required for the completion of the Simplon tunnel, however, the development of electric traction on railways has been such as to cause the original plan to be abandoned. Especially had the success with the three-phase traction on the Valtellina line of the Adriatic system in Northern Italy drawn attention to the subject, while the existence of power generating plants in connection with the construction works on the tunnel also aided in making the decision as to the employment of electric locomotives in the operation of transportation through the tunnel from the very commencement of the service.

In a recent issue of *Le Génie Civil* there is given a detailed account of the electric locomotives now under construction for the tunnel service, and from this paper, by Mr. S. Herzog we give some description of these important machines.

Since the short space of time remaining between the decision to use electric traction and the opening of the tunnel rendered it impracticable to have the new locomotives completed in time it was decided to make use of an offer of the Italian Adriatic Railway System and accept the use of two electric locomotives, built by Brown, Boveri & Co., of Baden, and intended to be added to the equipment of the Valtellina railway. These engines, designed for three-phase current at 3,000 volts, 15 periods, are to be put into regular service in the tunnel on June 1, of this year, at which date the regular train service is to be inaugurated.

The original specifications for the Valtellina locomotives provided for a chassis mounted on two bogie trucks, and two driving axles, the load on each driving axle not to exceed 14 metric tons, and no gearing to be used between the motors and the driven axles of the locomotive. Two normal speeds were to be provided, the speed change to be made by pole commutation, the normal speeds to be 30-40 kilometres, and 60-70 kilometres per hour, or say 25 and 40 miles. At these speeds the tractive power should be not less than 6,000 kilogrammes at the low speed, and 3,500 kilogrammes at the high speed. The period of acceleration from standing to a speed of 30 kilometres, on a level track or up a grade of less than 0.1 per cent, with a train of 400 tons, including the locomotive, was specified to be within 55 seconds. A train of 250 tons, under the same conditions, was required to attain a speed of 60 kilometres in 110 seconds. A speed of 30 kilometres was required with a train of 250 tons, up a 2 per cent grade. The specified efficiencies were 85 per cent at the high speed, and 80 per cent at the lower speed, and the motors were required to keep at a temperature not exceeding 40 degrees C. above the surrounding air, even with an overload of 100 per cent during 200 seconds, or an overload of 50 per cent during an hour. During a run of ten hours under full load at either of the normal speeds the temperature of no part of the machine, including the bearings of any portion of the motors, should exceed 60 degrees above that of the atmosphere.

These requirements were followed in general, except that the design was modified to permit the use of three driving axles, the two motors being raised above the locomotive axles, and connected to the drivers by a triple-headed parallel connecting rod.

The general structural details of the two locomotives now to be put into service in the Simplon tunnel are fully illustrated in the article of M. Herzog but some of the principal points may be given here. The total weight is 62 tons, of which 42 tons are carried on the drivers, these latter being 1.64 metres in diameter, and the total length of the engine 12.32 metres. The normal power of the two motors is given as 900 horse power, and the maximum as 2,300 h, p, or 1,150 h. p. per motor, and this, for a weight of 10.75 tons for each motor represents the minimum weight for the power which has yet been attained.

In the Ganz system, used in the earlier Valtellina locomotives the speed change was effected by the arrangement of the motors in cascade, and this method is still to be employed in the new engines now under construction by the same firm. In these locomotives by Brown, Boveri & Co., however, a saving in weight of 2.5 tons per motor has been made by abandoning this system and producing the speed change by varying the number of poles in the stator; by changing from 16 to 8 poles the velocity is changed from 112 to 224 revolutions.

The general arrangement of the contacts for taking the current is similar to that used on the Valtellina locomotives except that the sliding contact trolley arms are so arranged that they can be lowered to the horizontal position when in the tunnel, thus bringing all parts of the locomotive within the normal loading gauge of the Swiss and Italian railways.

At the present time the electric current is to be furnished by the hydro-electric stations at Brieg and Iselle, situated on the Rhone and on the Diveria, their respective capacities being 1200 and 1500 horse-power. It is estimated that trains passing from north to south will require 20 minutes in passing through the tunnel, and 30 minutes in going the opposite direction, the latter traverse being the slower because of the up grade.

There can be little doubt as to the wisdom of making the change from steam to electric traction, so far as the Simplon tunnel is concerned, from the very start. The advantages of the route, so far as the shortening of distance between Italy and the North Sea ports will appear immediately, but France cannot expect to reap the benefit which should be hers until some definite settlement as to the connecting routes is made, and even after the plans have been accepted there will remain much construction work to be done. There is no question, however, that passenger traffic would be largely directed toward the route which offered electric traction through the long tunnel, and assured immunity from the smoke and gas now so oppressive in the Mont Cenis tunnel, and rapidly becoming a nuisance also in the St. Gothard. Probably the influence of the change will be felt on these older routes as well, and we may soon expect to hear of the electrification of both of the earlier tunnels, to the increased comfort of travellers by all routes.

Similar results may be expected upon the railways of northern Italy, where the example of the Valtellina line has already demonstrated the feasibility of electric traction. The great number of tunnels necessary in crossing the Apennines, and the material discomfort to tourists and other travellers through one of the most attractive regions of Europe over present routes, cannot but render the introduction of smokeless traction inevitable. When to these inducements is added the fact that abundant sources of hydraulic power await development and direction, in a country entirely lacking in coal resources, the situation is seen to be ripe for the transformation.

The contest between direct and alternating currents for main-line traction will doubtless be settled by the severe test of experience, and in the Simplon tunnel as on the Valtellina lines the three-phase system will show its worth, while, before very long the capabilities of the direct current for heavy main-line traction will be demonstrated on the New York Central Railroad.

In Switzerland the whole subject of electric traction on main-line railways has been placed in the hands of a government commission, and this commission has made a preliminary report, based upon an examination of the Burgdorf-Thun line, using an alternating current low-tension system; the Fribourg-Monet-Anet line, using direct current with third rail; the Valtellina line, above referred to, and using high-tension three-phase current; and the Milan-Gallarate-Porto Ceresio line, employing low-tension continuous current.

A study is at present also being made of the operation of the Paris Metropolitaine, and of the electric operation of the Paris terminus of the Orleans railway. The next studies will be of some of the German lines, with especial reference to the possibilities of the single-phase system, and not until these various studies have been worked out can a final report be expected, the present report being only a record of the work now being conducted in connection with these comparative examinations.

THE ENGINEERING INDEX

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Excavating and Concreting the New York Anchorage of the Manhattan Suspension Bridge. Illustrates and describes methods. 2500 w. Eng Rec—March 3, 1906. No. 75404.

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Computations for Arches Fixed at the Springings (Note Sur le Calcul des Arcs Encastre's). M. Pigeaud, Develing formulas from which working tables are computed, enabling the computations for arches rigidly built into the springings to be made by inspection. 6000 w. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75773 E + F.

Computations for Single-Span Arches (Berechtonung von Eingespannten Gewölben). E. Mörsch. A mathematical treatment, giving analytical and graphical solutions according to the elastic theory. Two articles. 4000 w. Schweiz Bauzeitung—Feb. 17, 24, 1906. No 75750 each B.

Construction Methods at the Stone Bridge at Hartford, Conn. There are seven elliptical arches of 119 to 68 feet span of cut granite. Details of the centerings and the very effective methods of erection are given. 1500 w. Eng Rec—March 3, 1906. No. 75403.

The Danville Arch Bridge of the Cleveland, Cincinnati, Chicago & St. Louis Railway. An illustrated detailed description of a double-track reinforced concrete bridge of unusual design and its construction. 4300 w. Eng Rec—March 3, 1906. No. 75385.

The Graphical Construction of Parabolas of the Fourth Degree (Tracé Graphique des Paraboles du Quatrième Degré). Farid Boulad. A discussion of the relation of the parabola to the lines of influence of arches, and to the shearing stresses on beams. 7000 w. Ann des Ponts et Chaussées—3 Trimestres, 1905. No. 75775 E + F.

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Strauss Bascule Bridges. Two designs of trunnion bascule bridges are illustrated and described. 800 w. R R Gaz—Vol. X. L., No. 11. No. 75553.

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The Permissible Stresses upon Iron Bridge Members with Reference to their Resistance to Buckling (Zur Frage übe, die Zulässige Inanspruchnalime Eiserne Brückenorgane hinsichtlich des Widerstandes gegen das Zerknicken). Joh. E. Brik. An examination of the buckling stresses in framed structures, deriving formulas and tables for practical use in bridgebuilding. 4000 w. Oesterr Wochenschr f d Deffent Bandienst—March 3, 1906. No 75764 D.

Curved Trusses.

Computations for Curved Bridges (Calcul des Ponts Courbes). M Résal. A discussion of the stresses in bridges in which there is a horizontal curve between piers; with especial reference to the cross strains. 5000 w. Ann des Ponts et Chaussées—4 Trimestre, 1905. No. 75780 E + F.

Erection.

Erecting the Floor Systems and Lower Part of Trusses, Island Span, Blackwell's Island Bridge, New York. Illustrated detailed description of the sequence of operations. 1500 w. Eng Rec—March 17, 1906. No. 75571.

Erection of the Upper Part of the Trusses of the Island Span of Blackwell's Island Bridge, New York. Illustrated description of the work. 2200 w. Eng Rec—March, 3, 1906. No. 75399.

The Erection of the Miramichi Bridge. A truss bridge for the Intercolonial Railway across the southwest branch of the river, above Newcastle, New Brunswick. Six 204 ft. spans on stone piers. Completed spans floated into place in pairs on scows. 1300 w. Eng Rec—March 24, 1906. No. 75685.

Highway Bridge.

The New Portland Bridge. H. A. Crafts. Replacing an old bridge across the Willamette River, Portland, Oregon. One 200 ft. skew span, two 269 ft. common span, and a 384 ft. draw span, all steel trusses. Some difficult work with pile foundations for piers is discussed. 1000 w. Eng Rec—March 3, 1906. No. 75391.

Reconstruction.

Rebuilding the Housatonic River Bridge of the New York, New Haven & Hartford at Sandy Hook, Conn. Extract from a paper by A. H. Terry, before the Conn. Soc. of Civ. Engrs. on speed of constructions as illustrated by methods employed in replacing Bridge No. 105. Ills. 1800 w. R R Gaz—Vol. XL., No. 13. No. 75836.

Reinforced Concrete.

Arch Rib Bridge of Reinforced Concrete at Grand Rapids, Mich. George Jacob Davis. A type unusual in the United States, having reinforced slabs imbedded in the haunches, forming a pair of cantilevers. 2000 w. Eng News—March 22, 1906. No. 75647.

Ferro-Concrete Viaduct at Gennevilliers, near Paris. Illustrates and describes a viaduct erected to carry the branch of railway connecting the new gas works with a quay. It consists of 22 spans. 1000 w. Engng—Feb. 23, 1906. No. 75372 A.

Parabolic Reinforced Concrete Arch Bridge at Wabash, Ind. Illustrated description of a highway bridge having a rather unusual curve of the arch ring, a parabolic arc, and very complete reinforcement of the spandrel walls. 400 w. Eng News—March 15, 1906. No. 75527.

The Third Street Reinforced Concrete Bridge, Dayton, Ohio. Illustrated detailed description of the construction of a seven-span bridge on the Melan arch system. 2500 w. Eng Rec—March 24, 1906. No. 75682.

See also Civil Engineering, Construction.

Swing Bridge.

The Operation of the New Railway Bridge at Velsen (De Bewegings en Bedieningsinrichtingen der Nieuwe Spoorbrug te Velsen). J. J. W. van Loenen Martinet & F. C. Dufour. A detailed description of the swing bridge over the Noordzee Canal at Velsen, Holland, including the electrical operating mechanism. 4000 w. De Ingenieur—Feb. 17, 1906. No. 75782 D.

Transporter.

The Transport Bridge at the Old Port at Marseilles (Pont a Transbordeur sur le Port-Vieux à Marseille). G. Leinekugel le Cocq. Illustrating the erection and operation of a bridge of the transporter type on the Cantilever principle, with a clear span of 165 metres. Serial, Part I. 3000 w. Géine Civil—Feb. 24, 1906. No. 75715 D.

Wabash.

The Wabash River Bridge at Terre Haute, Indiana. Malverd A. Howe. Illustrated description of a new highway bridge having a rather unusual combination of trusses and plate girders. 2000 w. Eng News—March 8, 1906. No. 75438.

CONSTRUCTION

Building Construction.

Construction of the Title Guarantee and Trust Company Building, New York. The sand foundation is enclosed on all sides by sheet steel piling, and the cantilever beams for the support of the steel cage rest on an extensive grillage and concrete foundation. Ill. 3000 w. Eng Rec—March 17, 1906. No. 75574.

Extension of the Metropolitan Life Insurance Building, New York City. Describing the completion of the third section, with especial reference to the structural steel work and the reinforced concrete floor work and fireproofing. 3000 w. Eng Rec—March 3, 1906. No. 75409.

Building Details.

Special Column and Girder Details in the Office Building of the New York Central Lines. Describes the arrangements for excessive loads in a building that will have 20 stories when completed. 2000 w. Eng Rec—March 17, 1906. No. 75572.

Cement Pipe.

Method and Cost of Constructing Cement Pipe in Place. Halbert P. Gillette. Briefly describes the invention of Ernest L. Ransome, and the construction work, giving a report of cost. 1200 w. Eng Rec—March 10, 1906. No. 75479.

Concrete.

A large concrete Gas Holder Tank. A sunken concrete tank for a 5,000,000 cu. ft. gas holder recently built at the foot of 136th St., New York City, is illustrated and described. 2500 w. Eng Rec—March 3, 1906. No. 75394.

Erection.

Methods of Raising an Elevated Railroad Structure. Brief illustrated description of an interesting and rather unusual piece of work in progress in Chicago. 1500 w. Eng Rec—March 3, 1906. No. 75395.

Excavation.

Excavation for Dry Dock No. 4, Brooklyn Navy Yard. Describes this dock, now under construction, and the very difficult conditions to be met; also the preparations made to avoid trouble and delays. Ills. 2800 w. Eng Rec—March 3, 1906. No. 75398.

The Novel Methods of Excavating Building Sites in Chicago. Describes the methods adopted in order to enable contractors to employ the subway freight tunnels for the removal of material. Ills. 3000 w. Eng Rec—March 10, 1906. No. 75476.

Floors.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. Discussion of a paper by John S. Sewell, on this subject. Ills. 20500 w. Pro Am Soc of Civ Engrs—March, 1906. No. 75835 E.

Foundations.

Building and Machinery Foundations in Quicksand. Illustrates and describes methods used in building foundations for the Knickerbocker Building at 114 and 118 West 39th St., New York City. 2700 w. Eng Rec—March 3, 1906. No. 75388.

Substructure for the United States Express Company's Building. A 23-story building on Greenwich St., New York, which involved considerable difficulty in building the substructure, the foundations being carried through water and quicksand to rock at a depth of 41 ft., is illustrated and described. 4300 w. Eng Rec—March 3, 1906. No. 75411.

Grain Elevator.

New Grain Elevator for the Santa Fe System at Chicago. Illustrated description of a new elevator under construction, which possesses unique features of interest. 1100 w. Ry Age—March 23, 1906. No. 75811.

Reinforced Concrete.

Erection of a Reinforced Concrete Factory for the Bush Terminal Company. Illustrates and describes details in construction of this 75x300 ft. seven-story building in South Brooklyn, N. Y. The floors are calculated for loads of 800 lbs. per square ft. 2500 w. Eng Rec—March 3, 1906. No. 75400.

Formulas for Reinforced Concrete Beams. Henry Goldmark. Considers the advantages and objections of reinforced concrete, and the methods for calculating the stresses in reinforced concrete beams. 6800 w. Can Soc of Civ Engrs—Feb. 22, 1906. No. 75618 D.

Reinforced Concrete and Tile Construction, Marlborough Hotel Annex, Atlantic City, N. J. Illustrated detailed description of a building in which the framework, including columns, girders and roofs, is reinforced concrete, while the walls and floor filling are burnt clay hollow tile. 3500 w. Eng News—March 8, 1906. No. 75434.

Reinforced Concrete Suburban Residence Construction. William F. Tubesing. Illustrates two residences in the vicinity of Cincinnati, O., describing one in detail. 1100 w. Eng News—March 1, 1906. No. 75302.

The Design of Concrete Steel Beams and Slabs. Edward Godfrey. Aims to show that formulas for concrete-steel beams or slabs can be made as simple as those for steel beams. Discusses principles of design. 4000 w. Eng News—March 15, 1906. No. 75528.

The Determination of the Sliding Resistance in Reinforced Concrete Beams. Prof.Ramisch, in *Zeitschr, d Oesterr, Ing. Arch. Ver.* Discusses the proper method for the determination. 2000 w. Cement—March, 1906. No. 75613 C.

The Northwestern Ohio Bottle Company's Factory. Illustrates and describes a main building and a coal shed of the Ransome reinforced concrete construction. 1600 w. Eng Rec—March 24, 1906. No. 75688.

The Reinforced Concrete Factory for the American Oak Leather Co., Cincinnati. Sanford E. Thompson. Illustrated description of structural details of interest. 2500 w. Eng Rec—March 3, 1906. No. 75412.

The Shearing Resistance of Reinforced Concrete. S. Zipkes. Describes tests conducted by the writer dealing with the shearing resistance of plain and reinforced concrete. Ills. 1800 w. Cement—March, 1906. Serial. 1st part. No. 75612 C.

See also Civil Engineering, Bridges.

Roads.

Building a Marsh Highway near New York. Illustrated description of the construction of a road through a salt meadow, which is a part of an inlet from Long Is. Sound. 1200 w. Eng Rec—March 3, 1906. No. 75390.

Mountain Road Construction in Idaho. E. B. Darlington. An account of a system inaugurated to build mountain roads on engineering principles, and planned along systematic lines. 1800 w. Eng News—March 15, 1906. No. 75522.

The Corniche Road in the Maritime Alps (La Corniche de l'Estérel). M. Thérel. A historical and technical description of the construction of the famous Corniche road along the Riviera in the South of France. 15000 w. 2 plates. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75770 E + F.

Roofs.

Traveling Stages for Removal of Roof at Charing Cross Station. Illustrates and describes the method of removing this large roof and replacing by a different type, without interrupting traffic. 800 w. Engng—March 9, 1906. No. 75601 A.

Sanitation.

Sanitary Building Construction. Alfred Saxon Snell. Read before the Roy. San. Inst. Discusses conditions affecting the health that should be considered in building. 4000 w. Plumb & Dec—March 1, 1906. No. 75539 A.

Shoring.

Difficult Shoring Work for Buildings in Chicago. Explains conditions and illustrates and describes difficult work in erecting the Boston Store in the retail business district. 2700 w. Eng Rec—March 24, 1906. No. 75686.

Specifications.

Iron and Steel Structures. Abstract of a report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with general discussion. Considers specifications for steel bridges, loads, strains, designs, &c. 23500 w. Ry Age—March 23, 1906. No. 75821.

Subway.

See Street and Electric Railways.

Tall Buildings.

American Tall Buildings or Sky-Scrapers (Amerikanische Hochbauten Sogenannte Wolkenkratzer). F. Bohny. An illustrated description of the tall business buildings of the United States, with especial reference to Chicago and New York. Serial, part 1. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75704 D.

Tunnels.

The Construction of the Simplon Tunnel (Der Bau des Simplon tunnels). F. Pflug. Including a description of the surveys, rock drilling machinery and masonry work. Serial, Part I. 2000 w. Glasers Annalen—March 15, 1906. No. 75753 D.

The Construction of the Simplon Tunnel (Les Travaux du Tunnel du Simplon). M. Jacquier. A general description of the undertaking and its difficulties; reviewing the engineering peculiarities of the work, with statistics of the execution. 20000 w. 1 Plate. Ann d Ponts et Chaussées—4 Trimestre, 1905. No. 75777 E + F.

The New York & Long Island Railroad Tunnel. Information concerning the laying out of a double-track tunnel under the East River in the line of 42d St., New York, which is intended to bring electric cars from Long Is. to a point under the Grand Central Station and the Rapid Transit Subway Station. 3800 w. Eng Rec—March 3, 1906. No. 75393.

The Reconstruction of the Ossining Tunnel, New York Central R. R. Illustrates and describes the method of carrying out these improvements without interrupting the heavy traffic of freight and express trains. 2500 w. Eng Rec—March 3, 1906. No. 75392.

The Scranton Tunnel of the Lackawanna and Wyoming Valley Railroad. George B. Francis and W. F. Dennis. Illustrates and describes the construction of this tunnel which contains many interesting engineering features. 7000 w. Pro Am Soc. of Civ. Engrs—March, 1906. No. 75833 E.

Waterproofing Concrete.

Experiences in Water-Proofing Concrete, U. S. Fortification Work. Abstract from Annual Report from 1905 of the Chief of Engineers describing methods used. Ills. 1600 w. Eng News—March 15, 1906. No. 75532.

MATERIALS OF CONSTRUCTION.

Brick.

The Manufacture of Brick from Shale. Illustrated detailed description of a plant at Galesburg, Ill. 2700 w. Eng. Rec—March 17, 1906. No. 75573.

Cement.

Cement Burning. W. H. Hess. Discusses the relation of volume weight of raw cement material to the output of a rotary kiln. 1500 w. Cement Age—March, 1906. No. 75466.

Cement, Mortar and Concrete. Their Preparation and Use for Farm Purposes. Philip L. Wormley, Jr. Reprint from Bul. No. 235, issued by the Dept. of Agriculture. Describes a proper method of mixing concrete, and some points in construction which are of particular interest to farmers. 3500 w. Sci Am Sup—March 10, 1906. Serial, 1st part. No. 75433.

Manufacture of Hydraulic Cements. L. L. Stone. Read before the Univ. of Michigan Engng. Soc. A description of the processes of manufacture. 3000 w. Sci Am Sup—March 10, 1906. No. 75432.

Report of a Test on a Portland Cement Plant. E. C. Soper, Jr. Briefly refers to the history, growth and extent of this industry, describing a typical plant, comparing processes, and reporting tests. Discussion. 7500 w. Jour W Soc of Engrs—Feb., 1906. No. 75418 D.

Concrete Blocks.

The Ideal Concrete Block made Practical. Louis H. Gibson. Outlines the factors to be aimed at in the making of concrete blocks, discussing the principles and suggesting methods. 2800 w. Munic Engng. March, 1906. No. 75339 C.

Marble.

Marble Cutting for the New York Public Library Building. Describes the shop and equipment where this work is carried on. 2000 w. Eng Rec—March 3, 1906. No. 75389.

Marble Working in the Apuan Alps (Italy). Sig. Ernesto Oreglia. Abstracted from *Rassegna Mineraria.* Illustrates and describes the sawing of marble into blocks and the machines used, with other methods and appliances. 4200 w. Quarry—March, 1906. No. 75492 A.

Stucco.

The Manufacture of Plaster of Paris or Stucco. C. O. Bartlett. Describes the method of manufacture, and gives the machinery required. 600 w. Min Rept—March 1, 1906. No. 75349.

Timber.

The Shirley Plant of the Columbia Creosoting Company. Illustrated description of this plant in Indiana which is notable for its advanced ideas in timber preserving practice. 2000 w. R R Gaz—Vol. XL., No. 11. No. 75552.

The Santa Fe's Modern Timber Treating Plant at Somerville, G. B. Shipley. Illustrated detailed description of a plant in Texas to be operated on the Rueping patented creosoting process. 4800 w. Ry Age—March 23, 1906. No. 75814.

MEASUREMENT.

Curves.

The Plotting and Rectification of Curves Applied to the Quadrature and Determination of the Centre of Gravity of Circular Arcs (Die Bogenstreckung und ie Streckenbiegung angewendet zur Geviertung und zur Bestimmung des Schwerpunktes von Kreisteilen). Eduard Linsel. Deriving a number of convenient geometrical constructions for the rectification of curves. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1906. No. 75733 D.

Metrophotography.

The Reconstruction of Architectural Monuments from Photographs (Sur le Relève des Monuments d'Architecture d'Après leurs Photographies). M. Laussedat. A discussion of the method of combining a number of photographs from various points to form an accurate record of actual dimensions and position. 3000 w. Comptes Rendus—Feb. 19, 1906. No. 75721 D.

Surveying.

Tide Levels and Datum Planes on the Pacific Coast of Canada. W. Bell Dawson. Gives results with regard to datum planes and bench-marks as far as determined. 8800 w. Can Soc of Civ Engrs—Jan., 1906. No. 75616 D.

Tide Indicators.

Tide Level Indicators with Pneumatic Transmission (Indicateurs de Hauteur d'Eau à Courant d'Air Continu). MM. Vidal & Kauffmann. The pencil of a recorder is moved by the varying degree of Compression of air in a closed vessel according to the variations in head of water. 3000 w. Ann d Ponts et Chaussées—2 Trimestre, 1905. No. 75772 E + F.

Water Meters.

Resolutions of the Philadelphia City Council against Water Meters. A copy of the resolutions with brief editorial comment. 1500 w. Eng News—March 22, 1906. No. 75652.

MUNICIPAL.

Dust.

The Oiling of Roads (Gondronnages des Routes). M. Guillet. An account of the results effected by the use of oil to prevent dust on roads in the departments of Seine and Marne, from 1903 to 1905. 4000 w. Ann des Ponts et Chaussées—4 Trimestre, 1905. No. 75781 E + F.

Garbage.

A Notable Report on Garbage and Refuse Collection and Disposal at Columbus, O. Reviews the report and detailed estimates submitted and approved by experts, for a plant for the collection and disposal of garbage and rubbish, and the cost of maintaining and operating it. 3300 w. Eng News—March 15, 1906. No. 75533.

Municipal Ownership.

See Industrial Economy.

Sewage.

Sewage Purification and Refuse Incineration Plant, Marion, Ohio. George H. Pierson. Illustrates and describes the plant and method of operation. 4500 w. Eng Rec—March 17, 1906. No. 75569.

Sewers.

The Construction of the Tunnel Line Sewer at Syracuse, N. Y. Profile, plan and illustration, with description of work. 2200 w. Eng Rec—March 3, 1906. No. 75410.

The New Hamburg Main Sewer. Illustrates and describes interesting work in the extension of the Hamburg sewer system. 2200 w. Engr, Lond—March 9, 1906. No. 75603 A.

The Sewerage System of Centerville, Iowa. Notes on the design, construction and cost of a system to meet rather difficult topographical conditions, as described in a paper by Arthur J. Cox, before the Iowa Engng Soc. Ills. 2700 w. Eng Rce—March 24, 1906. No. 75687.

Street Traffic.

London Traffic. Captain G. S. C. Swinton. Discusses mainly the ordinary traffic of the streets and means of improving it. General Discussion. 14000 w. Jour Soc of Arts—March 2, 1906. No. 75491 A.

WATER SUPPLY.

Athens.

Ancient Water Supply of Athens, Greece. Describing parts of a modern waterworks which formed a part of a supply system dating back to the sixth century before the Christian era. 1000 w. Ills. Engr, Lond—March 2, 1906. No. 75511 A.

Conduits.

Cement Conduit at Cambridge, Mass. A 63-inch concrete conduit, 11,500 feet long, built in place, using steel forms and centres. The capacity, running full, is estimated at 30,000,000 per day. 1400 w. Fire and Water—March 3, 1906. No. 75344.

Toronto's Experience with Conduits. C. L. Fellowes. With a description of methods adopted in laying the 6-foot steel conduit. 2500 w. Can Soc of Civ Engrs—Jan., 1906. No. 75617 D.

Dams.

The Belle Fourche Dam, Belie Fourche Project, South Dakota. Raymond F. Walter. One of the largest earthen dams in the United States, now being built, is illustrated and described. 2500 w. Eng Rec—March 3, 1906. No. 75408.

The Changes at the New Croton Dam. Continued discussion of paper on this subject, by Charles S. Gowen. 8500 w. Pro Am Soc of Civ Engrs—March, 1906. No. 75834 E.

The Construction of the Trap Falls Dam, Bridgeport, Conn. Illustrated detailed description of the work. 1800 w. Eng Rec—March 24, 1906. No. 75683.

The Reinforcement of the Grosbois Dam (Consolidation du Barrage de Grosbois). M. Galliot. Describing the manner in which a second dam, with intermediate auxiliary reservoir was constructed to relieve the stresses on an older structure. 5000 w. 1 plate. Ann des Ponts et Chaussées—3 Trimestre, 1905. No. 75776 E + F.

Paris.

The Water Supply from the Loing and the Lunain (Derivation des Sources du Loing et du Lunain). MM. Bechmann & Babinet. A very complete description of the aqueducts, connections and general works of the latest addition to the water supply system of Paris; giving a flow of 50,000 cubic metres per day. 30,000 w. 11 plates. Ann des Ponts et Chaussées—3 Timestre—1905. No. 75774 E+F.

Potability.

The Relation of Sedimentation and Acid Mine Wastes to the Potability of the Lower Monongahela River. S. J. Lewis. Does not consider the sedimentation adequate for the removal of impurities. Also discusses the germicidal effect of acid mines wastes on pathogenic germs. 3000 w. Eng News—March 15, 1906. No. 75529.

Pumping.

Electric Pumping at Schenectady, N. Y. G. S. Hook. An illustrated description of this plant, now in continuous operation. 1600 w. Jour N Eng W-Wks Assn—March, 1906. No. 75567 F.

Purification.

Experiments with Copper-Iron Sulphate for Water Purification at Marietta, Ohio. Describes the water-works and the filtration, sedimentation and purification plants. The supply is drawn from the Ohio River. 3000 w. Eng Rec—March 24, 1906. No. 75684.

Regulation.

The Automatic Regulation of Flow of Water Plugs and Faucets (La Limitation Automatique du Debit dans les Bornes-Fontaines et Robinets). P. A. Bergès. A description of the various devices for public water supply so arranged as to prevent waste and limit the flow to the actual requirements. Series, Part I. Génie Civil—Feb. 17, 1906. No. 75712 D.

Regulators.

Water Pressure Regulators. A. O. Doane. Brief illustrated descriptions of various makes of regulators for equalizing the pressure in different parts of a distributing system. General discussion 5000 w. Jour N Eng W-Wks Assn—March, 1906. No. 75564 F.

Reservoirs.

A Reinforced Concrete Reservoir at Bloomington, Ill. The method of construction is illustrated and described. 3500 w. Eng Rec—March 3, 1906. No. 75401.

Construction Work on the Charles River Dam and Basin at Boston, Mass. J. Albert Holmes. Illustrates and describes bridge work, the coffer dams, and the Boston marginal sewer. 3500 w. Eng News—March 1, 1906. No. 75306.

The Construction of the Charles River Dam and Basin at Boston. John N. Ferguson. The completion of a temporary highway bridge and approaches, completion of the Boston coffer dam, dredging and pile driving, etc., are illustrated and described. 4500 w. Eng Rec—March 3, 1906. No. 75406.

The Hagerstown Reservoir. J. W. Ledoux. Explains the conditions to be met, and illustrates and describes the storage reservoir finally built. 1600 w. Eng Rec—March 3, 1906. No. 75386.

Siphons.

Experimental Results with Siphon Connections (Ueber Erfahrungen mit Heberleitungen). H. Metzger. A description of the water supply of the city of Bromberg, in Prussia, the water being taken from a number of wells through mains forming several siphons to the pumping station. 5000 w. Gesundheits-Ingenieur—March 10, 1906. No. 75754. D.

Stray Currents.

Electrolysis. A topical discussion with illustrations of the corrosion of pipes by stray electric currents. 6000 w. Jour N Eng W. Wks Assn—March, 1906. No. 75565 F.

Typhoid.

On the Present Relative Responsibility of Public Water Supplies and Other Factors for the Causation of Typhoid Fever. W. T. Sedgwick and C. E. A. Winslow. A discussion of the cause of this disease and the necessary steps to overcome it. The remedy is absolute and universal cleanliness. General discussion. 13000 w. Jour N Eng W. Wks Assn—March, 1906. No. 75566 F.

Water Meters.

See Civil Engineering, Measurement.

Wells.

Strainers for Driven Wells. Dabney H. Maury. Considers driven wells, and the fine and coarse strainers, reviewing the advances in strainer construction. Eng News—March 8, 1906. No. 75436.

WATERWAYS AND HARBORS.

Breakwaters.

A Curious Engineering Analogy in Connection with the Design of the Cleveland Breakwater. Gives report and drawing of a design made in 1877 showing its similarity to types recently built at Buffalo and Cleveland. 1200 w. Eng News—March 15, 1906. No. 75530.

The Sandy Bay Breakwater, National Harbor of Refuge, Cape Ann, Mass. Describes a breakwater which will rank as the most extensive structure of its kind in the United States, so far as depth of water, size and cost are concerned. Ills. 3000 w. Eng News—March 8, 1906. No. 75435.

Canal Lifts.

Helicoidal Canal Lift (Ascenseur pour Bateaux, à Mouvement Hélicoidal). Ch. Dantin. A description of the Oelhafen-Löhle system for raising canal boas from a lower to a higher level. 1500 w. Géinie Civil—Feb. 17, 1906. No. 75713 D

Lift Tanks on Rollers Ueber Trogschleusen auf Walzen). Fr. Jebens. Describing an improved form of roller track bearings for tanks to be used on inclined plains for canal lifts. 2000 w. Glasers Annalen—March 1, 1906. No. 75723 D.

Trent-Valley Canal Hydraulic Lift-Lock. J. J. Bell. Information and illustrated detailed description of the hydraulic lift-lock at Peterborough, Ontario. 3500 w. Engng—March 16, 1906. No. 75805 A.

Embankments.

The Feuerlöscher System of Concrete Cylinder Construction (Die Betonsenkwalze nach der Bauweise Feuerlöscher). Fritz Hromatka. Describing a method of moulding concrete into cylindrical masses for use in submerged river-embankments construction. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 17, 1906. No. 75763 D.

Euphrates.

Plan for the Regulation of the Euphrates (Projet de Régularisation de l'Euphrate) F. Chochod. A description of the Hindieh canal and the plans for a barrage for the distribution of the waters for the Euphrates near Hilleh. 1500 w. Génie Civil—March 10, 1906. No. 75719 D.

Excavation.

Excavation of the West Neebish Channel, near Sault Ste. Marie. Work for the improvement of this channel of the St. Mary's River to increase the capacity of the connection between Lake Huron and Lake Superior is illustrated and described. 2400 w. Eng Rec—March 3, 1906. No. 75413.

India.

The Navigable Waterways of India. Robert Burton Buckley. Information, with maps, of the artificial and natural waterways of India, and matters relating to them. General discussion. 12500 w. Jour Soc of Arts—March 2, 1906. No. 75,490 A.

Jamaica, W. I.

Works for the control of the Wag Water River. J. Mark Fletcher. Describes the conditions existing in many rivers of the island of Jamaica, and the controlling works for the river named. Ills. 1000 w. Eng Rec—March 3, 1906. No. 75414.

Lighthouse.

The Diamond Shoals Lighthouse. Illustrated description of a proposed structure off Cape Hatteras. Steel and concrete will be used in the construction. 2000 w. Sci Am—March 24, 1906. No. 75635.

Panama.

A Proposed Plan for Excavating the Culebra Cut. Presents a plan worked out by Mr. John F. Wallace for the sequence of operations where the elevation is greatest and the largest volume of material to be removed. 2000 w. Eng News—March 1, 1906. No. 75303.

A Trip Through the Panama Canal in 1915. An illustrated description of the canal that is recommended with a presentation of the reasons that led the Commission to decide in favor of a canal with locks and high-level lakes. Editorials and article on sanitation of the canal zone included. 6000 w. Sci Am—March 10, 1906. No. 75430.

Preparing the Isthmus for Canal Construction Work. Fullerton L. Walds. An illustrated description of the conduct of sanitary work on the Isthmus, showing the extent of the measures which have been initiated, and the manner in which they are being carried out. 2500 w. Engineering Magazine—April, 1906. No. 75785 B.

Questions of Safety in a Lock Canal at Panama. Extracts from the Minority Report of the Board of Consulting Engineers for the Panama Canal. 3800 w. Eng Rec—March 17, 1906. No. 75570.

Shall the Panama Canal Be built by Contract? Editorial discussion of this subject, quoting from expressed views of Mr. J. F. Wallace. 3000 w. Eng News—March 15, 1906. No. 75531.

Some Concrete Work in Panama. Howard Egleston. The building of a sea-wall at Borcas del Toro is illustrated and described. 1200 w. Eng Rec—March 3, 1906. No. 75,396.

Some Phases of the Panama Problem. John F. Wallace. Abstract of an address delivered before the Illinois Manufacturers' Assn. Remarks on the construction of the canal, the Téhuantepec railroad, the Panama railroad and the rates. 3000 w. Ry Age—March 9, 1906 No. 75473.

Testimony of Mr. John F. Wallace before the Senate Committee on Interoceanic Canals A condensed abstract of such features of the testimony as are of interest to engineers. 12500 w. Eng News—March 1, 1906. No. 75304.

The Adopted Plan for the Panama Canal. Editorial discussion favorable to a lock canal. 2700 w. Eng News—March 1, 1906. No. 75305.

The Gatun Dam of the Panama Lock Canal Project. Extracts from the Minority Report of the Board of Consulting Engineers for the Panama Canal. Describes the proposed dam, presenting reasons for the choice of this site and information concerning the construction and cost. 4500 w. Eng Rec—March 10, 1906. No. 75477.

The Panama Canal. A. G. Menocal. Submits, for discussion, a modification of the canal route recommended by the Isthmian Canal Commission of 1899-1901 for a lock canal, by which the River Chagres may be kept under absolute control. 4 plates. 2200 w. Pro Am Soc of Civ Engrs—Feb. 1906. No. 75340 E.

The Panama Railroad and the Canal. Fullerton L. Waldo. An illustrated article describing the improvements made in the Panama Railroad and the work expected of it. 800 w. R R Gaz—Vol. XL., No. 9. No. 75316.

ELECTRICAL ENGINEERING

COMMUNICATION.

Multiple Telegraphy.

The Application of the Hughes System to Multiplex Telegraphy (Ein System für Wechselzeitige Mehrfach telegraphic mittels Hughes-Apparaten). Karl Hansel. With details of the wiring, relay connections and synchronizing, to adapt the Hughes printing telegraph to duplex and multiplex service. Two articles. 5000 w. Elektrotech u Moschinenbau—March 4, 11, 1906. No. 75748 each D.

Telephony.

The Telephone System of the Future—The Semi-Automatic. Le Roy W Stanton. Outlines this system, presenting its advantages. 1200 w. Elec Rev, N. Y.—March 10, 1906. No. 75448.

Telharmony.

Electrical Music. Describes a system Proposed by Dr. Thaddeus Cahill for generating music at a central station and distributing it by means of wires, any distance, as loud as though the orchestra were on the spot. It is produced entirely by electrical apparatus. Ills. 2800 w. Sci Am—March 31, 1906. No. 75825.

The Generating and Distributing of Music by Means of Alternators. Illustrates and describes the electric music generating system of Dr. Thaddeus Cahill, which enables music to be heard, loud enough to fill the largest auditorium, at places many miles distant. 2000 w. Elec Wld—March 10, 1906. No. 75483.

DISTRIBUTION.

Insulation.

Paper CVersus Rubber Insulation for Electric Cables. W. I. Tamlyn. Discusses the cost, life, and electrical properties of the two kinds of insulation. 1600 w. Eng News—March 15, 1906. No. 75526.

Oil-Switch.

The Ferrati New Three-Phase Remote-Control Oil-Switch. Describes the latest development of the oil breaking system. 1200 w. Sci Am Sup—March 31, 1906. No. 75832.

Safety Devices.

Circuit Breakers Newton Harrison. Explains the function of the breaker, and gives a classification with respect to the direction and amount of current, and illustrates and describes types. 5000 w. Cent Sta—March, 1906. No. 75467.

Fuses. Dean Harvey. An illustrated article discussing their characteristics, standardization, and types. 2500 w. Elec Jour—March, 1906. No. 75629.

Notes on the American System of Fuse Standardization. Alfred Schwartz. Showing that both on the Continent and in America the fuse has received more attention than in England. 1800 w. Elec Rev, Lond—March 2, 1906. No. 75501 A.

The Operation of Circuit Breakers and Fuses. Prof. E. W. Marchant, and F. A. Lawson. A report of experiments made to determine exactly what size of fuse it was possible to have in series with a given circuit breaker to put it in action without blowing the fuse. 1200 w. Elect'n, Lond—March 2, 1906. No. 75503 A.

Substations.

See Street and Electric Railways.

Three-Phase.

Simple Diagrams for Three-Phase Power Calculations. Alfred Still. Explains by the use of vector diagrams what is to be understood by the real and apparent power of the three-phase circuit under various conditions as regards load. 1500 w. Power—March, 1906. No. 75384 C.

Three-Wire.

Balancers. Budd Frankenfield. A comparison of the direct-current motor generator and the alternating-current auto transformer. The comparison is limited to symmetrical three-wire systems of distribution or systems for which the voltages between either main and the neutral are approximately equal. 1500 w. Elec Rev, N. Y.—March 10, 1906. No. 75446.

Wiring.

Conduit Wiring for Electric Installations. Abstract of a paper read before the Elec. Contractors' Assn. Reviews the practice of electric wiring, discussing the various conduits used and methods of installing. 3000 w. Electn, Lond—March 2, 1906. No. 75504 A.

Electrical Conduit Work in Fireproof Buildings. Thomas W. Poppe. Illustrated discussion of the best methods. 1000 w. Elec Wld—March 3. 1900. No. 75359.

Residence Wiring. Louis J. Auerbacher. Gives sample specification for a four-story and basement house having wooden floors and partitions, with analysis, and detailed description of apparatus. 4500 w. Elec Wld—March 3, 1906. No. 75358.

The Slide Rule as a Substitute for the

Wire Table. Carl P. Nachod. Outlines methods for resistance calculations which are extremely rapid, yet accurate. 900 w. Elec Wld—March 3, 1906. No. 75357.

ELECTRO-CHEMISTRY.

Electric Smelting.

See Mining and Metallurgy, Iron and Steel.

Electro-Metallurgy.

Electro-Technical Industries, Reviews the achievements in the electric-metallurgical field during the last half-dozen years. 1800 w. Sci Am Sup—March 31, 1906. No. 75831.

Nitrogen.

Electro-chemistry and the Problem of the Fixation of Atmospheric Nitrogen (La Fixation de l'Azote et l'Electrochimie). Philippe A. Guye. A study of the methods of fixation of atmospheric nitrogen showing the problem to be one of electro-chemistry, and dependent upon the low cost of electrical energy. 4000 w. Rev. Gen. d'Sciences. Jan. 15, 1906. No. 75768 D.

The Artificial Production of Nitrates from the Atmosphere. Gives views of the factory in Notodden, Norway, where nitrate lime is being manufactured by the Birkeland and Eyde process, with information concerning the work. 1300 w. Engr, Lond—March 16, 1906. No. 75801 A.

The Production of Nitric Acid by Explosive Combustion (Darstellung von Salpetersäure mittels Explosiber Verbrennung). Hr. Häuser. Describing a scheme for producing nitric acid by the explosive combustion of nitrogen and oxygen by the electric spark in the cylinder of a gas engine; thus utilizing the power of the explosion. 3500 w. Zeitschr d Ver Deutschr Ing—Feb. 24, 1906. No. 75707 D.

The Utilization of Atmospheric Nitrogen (Utilization de l'Azote Atmospherique). E. Lemaire. A review of the electrical methods for the fixation of atmospheric nitrogen. Serial, Part I. 3000 w. Génie Civil—March 10, 1906. No. 75718 D.

ELECTRO-PHYSICS.

Analogies.

Analogies Between Light and Electric Waves.—Braun's Experiments. Prof. B. Dessau, in *Umschau.* Reviews some experimental studies of the electro-magnetic theory of light, especially the experiments of Braun. 1200 w. Sci Am Sup—March 3, 1906. No. 75322.

Currents.

Idle Currents. M. B. Field. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the losses from idle currents in main conducting circuits. 2700 w. Elec Engr, Lond—Feb. 23, 1906. No. 75367 A.

Discharge.

Recent Investigations Upon the Mechanism of the Disruptive Discharge (Recherches, Recente sur le Mécanisme de la Décharge Disruptive). M. Langevin An examination of disruptive electrical discharges in the light of the electron theory, showing their bearing upon the study of the nature of electricity. 7000 w. Bull Soc Int des Electriciens—Feb., 1906. No. 75760 G.

Hysteresis

Magnetic Hysteresis (L'Hysteresis Magnetique). P. Duhem. A study of the phenomena of magnetization in fields of varying intensity, and a discussion of the consequent effects of hysteresis. Two articles. 7500 w. Rev Gen d Sciences --Jan. 15, 30, 1906. No. 75767 each D.

Lightning.

Lightning and the Electricity of the Air. Alexander G. McAdie. Reviews the investigations of Franklin and his co-laborers in this field, and of later investigations to the present time, discussing the protection from lightning and related subjects. Ills. 11700 w. Jour of Elec—March, 1906. No. 75471 C.

Magnet Coils.

Graphical Determination of the Dimensions of Magnet Coils. C. Kinzbrunner. Gives curves used for the determination of the dimensions, explaining how they are obtained. 900 w. Elec Engr, Lond—March 2, 1906. No. 75498 A.

Radio-Activity.

Cathode Rays in a Magnetic Field (Les Rayons Cathodique dans le Champ Magnetique). P. Villard. A study of the behaviour of the corpuscles in magnetic fields of various intensities and distribution. 7000 w. 4 Plates. Bull Soc Int des Electriciens—Feb. 1906. No. 75759 G.

Self Induction.

Self-Induction Effects in Steel Rails. Ernest Wilson. An account of experimental investigations, with results. 2800 w. Electn, Lond—Feb. 23, 1906. No. 75365 A.

Sparks.

The Heating Effect of the Electric Spark. Henry A. Perkins. A report of research work, with conclusions. Also editorial. 3000 w. Elec Wld—March 24, 1906. No. 75691.

GENERATING STATIONS.

Alternators.

Johannesburg Alternators. Illustrated description of some large alternate-current dynamos of the two-phase type, for coupling with gas-engines which run at 100 r. p. m. Reports their trial. 1000 w. Elec Engr, Lond—March 16, 1906. No. 75669 A.

Armatures.

The Distribution of Magnetic Induction and Hysteresis Loss in Armatures. Dr. W. M. Thornton. Read before the Newcastle Loc. Sec. of the Inst. of Elec. Engrs. A study of magnetic distribution, analysing the results. Ills. 1400 w. Elec Engr, Lond—March 9, 1906. Serial, 1st Part. No. 75592 A.

Auxiliaries.

The Betterment of Power-Station Economy by Electric Auxiliaries. Arthur S. Mann. Showing the importance of balancing the advantages of electrically operated auxiliaries against the value of the exhaust steam for heating purposes. 2500 w. Engineering Magazine—April, 1906. No. 75788 B.

Central Stations.

Central Station Power. E. F. Espenschied, Jr. On the use of power in the industries and so increasing the revenue producing hours, the motors required, etc. Discussion. 4000 w. Pro. Engrs' Soc of W Penn—March, 1906. No. 75-621 D.

Dynamos.

A study in the Design of a 500-K. W. Continuous-Current Generator. Dr. Max Breslauer. Determines a common basis for the comparison of the different formulae generally used as a criterion for the sparking conditions, and discusses the figures and dimensions of this special machine. Ills. 3300 w. Electn, Lond—March 9, 1906. Serial, 1st part. No. 75593 A.

The Conversion of Energy in Dynamo-Machines (Ueber die Umwandlung der Energie in Dynamomaschinen). Karl Pichelmayer. A general study of the transformation of energy and the theories of leading physicists, with illustrations taken principally of electrical machinery 4000 w. Elektrotech u Maschnnebau—Feb. 25, 1906. No. 75746 D.

Hartford.

The Dutch Point Station of the Hartford Electric Light Company. Illustrated description of a new steam-turbine-driven station. 2000 w. Elec Wld—March 3, 1906. No. 75353.

Houston, Tex.

The Houston, Tex., Lighting and Power Company. An illustrated article giving information of the recently improved plant of this company and its equipment and operation. 3000 w. Elec Wld—March 24, 1906. No. 75690.

Hydro-Electric.

Construction of the Neale Shoals Power Plant on Broad River, S. C. Francis J. Sellew. Description, with illustrations, of the engineering details and methods of construction employed on a recently completed plant. 8000 w. Eng Rec—March 3, 1906. No. 75397.

Hydro-Electric Enterprise in Canada. Paul N. Nunn. Illustrates and describes the development of the Ontario Power Company, at Niagara Falls. Presented at convention of the A. I. E. E. 4500 w. Can Engr—March, 1906. No. 75482.

Notes and Designs of Hydro-Electric Power Stations. (With Reference to the Influence of Load Factor.) David B. Rushmore. Discussion with diagrams of various features, with particular reference to the economic side of such plants and electric transmission of power. 4000 w. Am Inst of Elec Engrs—March 23, 1906. No. 75658 D.

Power Development at St. Croix Falls for the Minneapolis General Electric Company. Adolph Edsten. General plan and illustrations with description. 2300 w. Eng Rec—March 3, 1906. No. 75405.

The Feistritzhammer Electric Station at Krieglach. (Elektrizitätswerk Feistritzhammer in Krieglach.) G. Witz. An illustrated description of a plant deriving 350 h. p. from the river Mürz, at Krieglach in Styria. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1906. No. 75732 D.

The Relation of Load-Factor to the Evaluation of Hydroelectric Plants. S B. Storer. Discussion and diagrams showing the effect of load factor upon steam and water driven electric plants respectively, and a conclusion that with constant flow of water, the earning power, and hence the value of the hydroelectric plant is proportional to the load factor. 1000 w. Am Inst of Elec Engrs—March 23, 1906. No. 75657 D.

Two Interesting Tyrol Hydroelectric Plants. Franz Koester. Brief illustrated descriptions of the plants at "Malserheide," near Glurns, and "Reinzwerke" of the City of Brixen. 2000 w. Elec Rev, N. Y.—March 24, 1906. No. 75665.

Utilization of the Waters of Lake Titicaca, Peru. Emile Guarini. Proposes a rather unusual plan for furnishing Peru with cheap power and afterwards utilizing the water for irrigation. 1300 w. Elec Rec, N. Y.—March 24, 1906. No. 75664.

Isolated Plant.

The Design of an Isolated Power and Lighting Plant. Putnam A. Bates. From a paper read at meeting of the Elec Engng Soc of Columbia Univ. Describes a plant installed to serve several machine shops. 2400 w. Eng Rec—March 10. 1906. No. 75480.

Management.

Power Plant Operation and Management. H. Schreiber. Discusses points of importance in securing economy and reliability. 2200 w. Jour of Elec—March, 1906. Serial, 1st part. No. 75469 C.

Motor Generators.

Some Features Affecting the Parallel Operation of Synchronous Motor Generator Sets. J. B. Taylor. Details of construction, connections, and method of operation to insure a desired diversion of load among such units, consisting of synchronous motors directly connected to alternating current generators. Diagrams and Ills. 4500 w. Am Inst of Elec Engrs—March 23, 1906. No. 75656 D.

N. Y. Central.

The Steam-Electric Power Stations of the New York Central Railroad. Illustrated detailed description of the two power stations which are to supply electric current for the operation of suburban trains. 3500 w. Power—March, 1906. No. 75381 C.

Station Design.

The Design of a Small Electric Power Station. James F. Hobart. The first of a series of articles dealing with the design, construction, selection and installation of machinery, operation of the plants, etc. 2500 w. Elec Wld—March 3, 1906. Serial, 1st part. No. 75356.

Switchboards.

Development in Design and Construction of Switchboards and Cable Runs for Large Direct Current Installations. Edward Schildhauer. An illustrated paper showing the development in switchboard design and construction of cable runs. 4500 w. Wis Engr—Feb., 1906. No. 75310 D.

Notes on Heavy Electric Switchgear. J. Whitcher. Abstract of a paper read before the Rugby Engng. Soc. A plea for simplicity in design, construction and operation, discussing details. 6000 w. Mech Engr—March 3, 1906. No. 75497 A.

LIGHTING.

Arcs.

Municipal Arc Lighting from Steam Turbine Power. Illustrates and describes the city plant at Columbus, Ohio. 2000 w. Elec Rev, N. Y.—March 10, 1906. No. 75447.

Carbons.

The Wilton Carbon Factory. An explanation of why this industry in England is threatened, and an illustrated description of the manufacture of arc lamp carbons as seen at Wilton. 2200 W. Elec Engr, Lond—March 16, 1906. No. 75668 A.

Frequency.

Electric Lighting with Various Frequencies (L'Eclairage Electrique aux Diverses Frequences). P. Lauriol. A study of the effects of alternating currents of various frequencies upon the flickering of incandescent lamps; showing that the choice of frequency should depend upon the nature of the service. 6000 w. Bull Soc Int des Electriciens—Feb., 1906. No. 75758 G.

Globes.

The Effect of Acid Frosting and Enclosing Globes Upon the Life of Incandescent Electric Lamps. J. R. Cravath and V. R. Lansingh. A report of interesting tests, with a study of the results. 1500 w. Elec Wld—March 17, 1906. No. 75590.

Interiors.

The Lighting of Miscellaneous Rooms in Residences. J. R. Cravath and V. R. Lansingh. An illustrated article intended to supplement two previous articles on residence lighting. Considers large parlors, kitchens, the porch, bath room, basement and hall. 2000 w. Elec. Wld.—March 3, 1906. No. 75354.

Photometer.

See Electrical Engng. Measurement.

Waste.

Waste in Incandescent Electric Lighting and Some Suggested Remedies. Abstract of the discussion in connection with Mr. George Wilkinson's paper on the above subject. 6000 w. Elect'n, Lond—March 16, 1906. No. 75680 A.

MEASUREMENT.

Bolometer.

Note on the Use of the Bolometer as a Detector of Electric Waves. C. Tissot. Describes investigations. 2000 w. Elec Engr, Lond—March 2, 1906. No. 75499 A.

Electrical Units.

International Conference on Electrical Units. Gives the final decisions of the conference held at Charlottenberg (Berlin), Germany, in October, 1905. 3500 w. Elec Wld—March 24, 1906. No. 75694.

Ohm.

Mercurial Standards of Electrical Resistance (Les Etalons Mercuriel de Résistance Electrique). C. E. Guillaume. A discussion of the paper of M. Girousse, showing the causes of variations in the resistance of a column of mercury in a glass tube. 5000 w. Bull Soc Int des Electriciens—Jan., 1906. No. 75757 G.

Standards for the Legal Ohm (Les Etalons de l'Ohm Légal). G. Girousse. An account of the work of the laboratory of the Superior School of Posts and Telegraphs, with especial reference to the production. and comparison of mercury standards for the ohm. 3500 w. Bull de la Soc Int des Electriciens—Dec., 1905. No. 75756 G.

Oscilloscope.

The Oscilloscope. Dr. Lewis Jones. Calls attention to Ruhmer's ingenious oscilloscope, which makes a graph of the discharge in high potential circuits by mapping the length of cathode rendered luminous by the discharge. Ills. 700 w. Elec'n, Lond—March 16, 1906. No. 75679 A.

Phasemeters.

Phasemeters and Their Calibration. W. E. Sumpner. Showing the method of calibrating the instrument by using direct currents of known values, and thus obtaining deflections corresponding to definite phase angles. 3500 w. Elect'n, Lond—Feb. 23, 1906. No. 75366 A.

Photometer.

The Globe Photometer. An illustrated account of this apparatus, the function of which is to give by one observation the value of the whole amount of light emitted by any source, such as an arc lamp, or an incandescent lamp. Information from a paper by Dr. Bloch. 1700 w. Elec Rev, Lond—March 16, 1906. No. 75670 A.

Potentiometers.

Deflection Potentiometers. H. B. Brooks. Abstract of a paper to be published in the *Bulletin* of the U. S. Bureau of Standards. Describes the principles upon which a deflection potentiometer has recently been constructed and put into service for voltage measurements in photometric work. Ills. 1500 w. Elec Wld—March 17, 1906. No. 75588.

Sparking.

Calculation of Dynamo Sparking Constants. A. Press. Presents empirical formulae apparently not difficult to apply. 1600 w. Elec Wld—March 10, 1906. No. 75485.

MOTORS.

Commutation.

Commutation in Single-Phase Motors at Starting. Marius Latour. A mathematical study of commutation when resistance leads are used. 2000 w. Elec Wld—March 10, 1906. No. 75484.

Induction Motors.

Repulsion Induction Motor. Maurice Milch. Explains the action of this motor, supplementing the explanation with characteristic curves obtained from tests on motors built for commercial purposes. 3000 w. Am Inst of Elec Engrs—Feb., 1906. No. 75343 D.

Iron Losses.

Iron Losses in Single-Phase Commutator Motors. Prof. Dr. F. Niethammer. Describes a simple experiment performed to ascertain in just what manner the iron loss varies with the speed. Diagrams, 700 w. Elec Wld—March 24, 1906. No. 75693.

Single-Phase.

A New Single-Phase Commutator Motor. V. A. Fynn. Illustrated description of a motor that can be built with either shunt or series characteristic. 12700 w. Inst of Elec Engrs—March 8, 1906. No. 75591 D.

Circle Diagram of Compensated Series Single-Phase Motor. E. C. Stone. Outlines the construction of the circle diagram. Editorial comment, 2500 w. Elec Wld—March 24, 1906. No. 75692.

Comparative Investigations of a Collector Motor (Verleichende Untersuchungen an einen Kollektormotor). R. Czepek. Data and results of tests of a seven horse power four-pole single-phase series motor. 3500 w. Elektrotech u Maschinenbau—March 11, 1906. No. 75749 D.

See also Street and Electric Railways.

Speed Control.

A Graphic Method of Showing the Action of Auxiliary Pole Variable-Speed Motors. Norman G. Meade. Diagrams and description. 300 w. Elec Wld—March 17, 1906. No. 75589.

Speed Characteristics and the Control of Electric Motors. Charles F. Scott. Discussing especially the practical methods of speed control of direct-current motors as applied to the driving of machine tools. 5000 w. Engineering Magazine—April, 1906. No. 75787 B.

The Lincoln Variable Speed Motor. Illustrated description of a four-pole shunt motor with the shunt field windings connected in series. 900 w. Ir Age—March, 1906. No. 75300.

Unipolar.

The Unipolar Machine as a Single-Phase Alternating-Current Motor (Die Unipolar Maschine als Einphasen-Wechselstrommotor). Josef Huppert. A brief examination of the operation of the acyclic dynamo, and the applicability of the machine to operation by single-phase currents. 1000 w. Elektrotech u Maschinenbau—March 4, 1906. No. 75747 D.

TRANSMISSION.

Cable Tests.

Tests of an Armored Cable for Three-Phase Current at 27,000 Volts (Essais d'un Cable Armé pour Courant Triphasé à 27,000 Volts). Data and results of tests upon a transmission cable between Entraygues and Toulon, under tensions as high as 90,000 volts, for a working tension of 27,000 volts. 1200 w. Génie Civil—Feb. 17, 1906. No. 75714 D.

Long Distance.

The Electrical Transmission of Power Over Great Distances. S. M. Kintner. Deals principally with the transmission of alternating current. Discussion. 5500 w. Pro Engrs' Soc of W Penn—March, 1906. No. 75622 D.

INDUSTRIAL ECONOMY

Coal Trade.

Wages and Profits in the British Coal Trade. T. Good. Gives facts and figures tending to prove that the coal miner receives fair wages, and that the profits are small. 1600 w. Cassier's Mag—March, 1906. No. 75608 B.

Education.

The Education of the Commercial Engineer. W. Bardill. Read before the Birmingham Assn. of Mech. Engrs. General remarks on education, with discussion of this special subject as viewed from the English standpoint. 4200 w. Engr, Lond—March 16, 1906. No. 75804 A.

Exposition.

Electricity at. the Liége Exposition (L'Electricite à l'Exposition de Liége). A series of illustrated reviews by various specialists of the various electrical exhibits at the Liége exposition. Serial, Part I. 4000 w. L'Electriciên—Jan. 6, 1906. No. 75765 B.

Finances.

The Finances of Engineering. William D. Marks. A discussion of the salaries paid engineers, and the business methods affecting them. 4500 w. Jour Fr Inst—March, 1906. No. 75559 D.

Geology.

Geology in Relation to Engineering. Stanley C. Bailey. An illustrated article showing the value of a good knowledge of geology to civil and mining engineers and architects; and calling attention to various cases where the knowledge is of use. 3000 w. Engr, Lond—March 16, 1906. Serial, 1st part. No. 75800 A.

Iron Ore.

Estimated Fifty Million Tons Iron Ore This Year. Editorial review of the ore shipments through the Sault canals since 1855, showing the increase, and commenting on the future outlook. 900 w. Min Wld—March 24, 1906. No. 75674.

Labor.

The Unemployed and Trades Unions. David McLaren Morrison. Claims that the number of the unemployed is due to the mistaken policy of the trades unions, and outlines a plan to provide age pensions and for sickness, and suggests following the example of Germany in confining those who will not work and forcing them to earn. 2000 w. Nineteenth Cent—March, 1906. No. 75659 D.

Mining.

Mining Stocks—How to Calculate Their Values. Francis C. Nichols. Gives statements, calculations, and tables aiming to bring together material which may be a guide to the proper understanding of the risks and oportunities in mining ventures. 3500 w. Min Wld—March 17, 1906. Serial, 1st part. No. 75579.

Municipal Ownership.

The Dalrymple Report. The full report of Mr. Dalrymple, of Glasgow, on the Chicago street railway situation. 8400 w. St Ry Jour—March 17, 1906. No. 75578 C.

Profit Sharing.

Profit Sharing as a Peace and Profit Maker. R. M. Downey. Read at meeting of the Nat. Metal Trds. Assn. Explains the plan adopted by the Keystone Driller Company, which is working to the satisfaction of all concerned. 2500 w. Ir Age—March 29, 1906. No. 75824.

Public Ownership.

The Ownership of Public Utilities. Lyman E. Cooley. Briefly discusses the problem in its historical and geographical aspect, giving the writer's conclusions. 3000 w. Jour W Soc of Engrs—Feb., 1906. No. 75417 D.

Specifications.

A Legal Criticism of Government Specifications. Suggestions based on conversations with contractors and a study of the decisions of the Supreme Court and Court of Claims, and experience in cases in those courts. 2000 w. Eng Rec—March 3, 1906. No. 75387.

Steel Corporation.

The United States Steel Corporation's Annual Report. Extracts from the report covering the operations of the fiscal year ended Dec. 31, 1905, showing the largest gross earnings in its history. 4000 w. Ir Age—March 22, 1906. No. 75633.

Wages.

Wages in the Engineering and Shipbuilding Industry in the 19th Century. A. L. Bowley and G. H. Wood. Abstracted from a paper read before the Statistical Society. Gives diagrams showing fluctuations of wages, and information of interest. Steady progress is shown. 3800 w. Ir & Coal Trds Rev—March 9, 1906. No. 75594 A.

Works Management.

The Square Deal in Works Management. O. M. Becker. Mr. Becker's fourth and concluding paper deals with the auxiliary methods of successful labor employers in developing the interest and welfare of their employees. 4000 w. Engineering Magazine—April, 1906. No. 75786 B.

MARINE AND NAVAL ENGINEERING

Boiler Explosion.

See Mechanical Engineering, Steam Engineering.

Breakdown.

A Marine Generating-Set Breakdown—Cause, Effect, and Repair. Illustrated description of a breakdown of an electric engine, discussing the cause 1500 w. Am Mach—Vol. 29, No. 10. No. 75428.

Electric Power.

Applications of Electricity on War Ships (l'Electricité à Bord des Navires de Guerre). G Maugas. A review of the applications of electricity on shipboard, including lighting, auxiliary motors, communication, etc., as well as the propulsion of submarines. 5000 w. Bull de la Soc Int des Electriciens—Dec., 1905. No. 75755 G.

Ferry House.

Fireproof Ferry Structure of the Lackawanna. Illustrates and describes an interesting method of construction to be used in rebuilding the ferry terminal at West 23d St., New York. The difficulties are explained, and the method of fireproofing. 1800 w. Ry Age—March 23, 1906. No. 75817.

Gas Engines.

See Mechanical Engineering, Combustion Motors.

Launch.

The Fifty-one Foot Cruising Launch Anita. Illustrated description. 800 w. Marine Engng—March, 1906. No. 75331 C.

Lifeboats..

The Government's Gasoline Lifeboats. Illustrated description of the latest design of lifeboat constructed for the United States Life-Saving Service. It is of the self-bailing, self-righting, non-sinkable type, and has a 20-h. p. gasoline engine of the four cylinder, auto-marine type. 1500 w. Sci Am—March 17, 1905. No. 75555.

Motor Boats.

A Serviceable Twin-Screw Motor Boat. Thomas J. Fay. Illustrates and describes the principal features of a new twin-screw boat fitted with two separate power plants. 1200 w. Sci Am—March 3, 1906. No. 75320.

Hydroplane Boats: Latest Type of High-Speed Craft. William M. Meacham. An illustrated article describing the writer's experiments with submerged plates, which lifted the hull of the boat out of the water, thus lessening the resistance. 1600 w. Sci Am—March 3, 1906. No. 75319.

Sixty Miles an Hour on the Water. Ernest Archdeacon. Translated from *La Vie Automobile.* Describes the hydroplane boat constructed by M. le Comte de Lambert, more than two years ago, and comments on the value of the principles of its design. 1100 w. Sci Am—March 3, 1906. No. 75318.

Steel Motor Boat for South America. Illustrated description of a steel hull, kerosene motor-propelled boat, built at Mariner Harbor, N. Y., for service on the Amazon River. 1000 w. Naut Gaz—March 1, 1906. No. 75345.

The "Spider" and the "Sandfly"—Two Shallow Draught Motor Boats. Illustrates and describes boats of very shallow draught; fitted with internal combustion engines. 700 w. Auto Jour—March 10, 1906. No. 75581 A.

Naval Engineers.

British Admiralty Policy and its Consequences. A discussion of the dissensions between the executive and the engineer officers in the British Navy, showing the insufficiency of the present Admiralty policy. 4000 w. Engineering Magazine—April, 1906. No. 75784 B.

The Efficiency of Engineering Personnel in the Navy. W. M. McFarland. A review of the natural consequences of the non-enforcement of the Personnel Law, and a plea for the discontinuance of the official discrimination between the two branches of the service in the United States Navy. 2500 w. Engineering Magazine—April, 1906. No. 75783 B.

Revenue Cutter.

United States Revenue Cutter No. 15. Illustrated detailed description of a steam revenue cutter for service in the waters of Albemarle and Pamlico sounds, on the Carolina coast. 1500 w. Marine Rev—March 1, 1906. No. 75325.

Shipbuilding.

A Survey of Scotch Shipbuilding in 1905. Benjamin Taylor. A review of the striking developments of a very successful year. 2400 w. Marine Engng—March, 1906. No. 75330 C.

The Shipbuilding and Shipping Industries of Germany. J. Ellis Barker. Reviews the development of this industry in Germany, especially in the last thirty years. 6800 w. Contemporary Rev—March, 1906. No. 75568 D.

Shipyards.

See Mechanical Engineering Machine Works and Foundries.

Steamers.

The China Navigation Company's Steamer "Huichow." Illustrates and describes one of six vessels recently built for service between China, Australia, the coast and rivers of China. 900 w. Engng —Feb. 23, 1906. No. 75373 A.

The P. & O. Twin-Screw Steamer "Mooltan." A series of illustrations of the latest steamer of this company, with information concerning the progress of the company during the past 35 years. 2300 w. Engng—March 9, 1906. Serial, 1st part. No. 75600 A.

Torpedo Boats.

The Development of the Torpedo-Boat Destroyer. W. J. Harding. Read before the Inst. of Marine Engrs., England. Historical review. Ills. 2500 w. Sci Am Sup—March 24, 1906. Serial, 1st part. No. 75637.

Torpedoes.

The Protection of Ships of War against Mines and Torpedoes (La Protection des Navires de Guerre contre les Mines et les Torpilles). R. Blochmann. A study of the lessons of the Russo-Japanese war; with suggestions as to the improvements in hull design, with reference to submarine protection. 2000 w. Rev Gen d Sciences—Jan. 30, 1906. No. 75769 D.

Transport.

The Military Transport Borussia (Der Truppentransportdanpmfer Borussia). Walter Hildebrandt. A fully illustrated description of the 7,500 ton transport recently completed at Kiel for the Hamburg-America Company. 2000 w. Schiffbau—March 28, 1906. No. 75762 D.

Trials.

Analyses of the Trials of the Ferry-Boat "Scranton." Graduating thesis of A. H. Potbury, E. A. Stevens, Jr., and O. von Voigtlander, with introductory by Col. E. A. Stevens. Description of test, with tables, explanations of methods, etc. 4500 w. Stevens Ind—Jan., 1906. No. 75534 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Brakes.

Automobile Brakes (Automobilbremsen). R. Lutz. Giving details of the various types of brakes used by the leading builders of automobiles, and their applicability as safety devices. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75702 D.

Carbureter.

Packard Automatic Carbureter. Illustrated description of an interesting example of American carbureter practice. The carbureter is fitted with a hot-circulating water jacket. 900 w. Automobile —March 15, 1906. No. 75542.

Clutches.

Hydraulic Clutches — —The Sparks-Boothby Clutch. Illustrated description of this clutch and its action. 1100 w. Auto Jour—March 17, 1906. Serial, 1st part. No. 75689 A.

Crawshay-Williams.

The 16 H. P. Crawshay-Williams Petrol Car. Illustrates and describes a British touring car. 1500 w. Auto Jour —Feb. 24, 1906. No. 75361 A.

Enfield.

The 30 H. P. Enfield Car. Illustrates and describes a recently built all-British car. 1000 w. Autocar—March 17, 1906. No. 75667 A.

Engines. ,

See Mechanical Engineering, Combustion Motors.

French Practice.

Trend of French Practice in Construction. Rene M. Petard. Gives some conclusions drawn from tendencies observed at the Paris Salon. 2000 w. Automobile —March 29, 1906. No. 75839.

History.

The Forerunners of the Automobile. F. M. Feldhaus. Illustrates and describes devices used as early as 1447, and later. 2000 w. Sci Am Sup—March 31, 1906. No. 75828.

Ignition.

Electric Ignition for Motor Cars. Frank Little. Discusses both low- and high-tension systems and their operation. Ills. 2200 w. Elec Engr, Lond—Feb. 23, 1906. No. 75368 A.

Industrial Vehicles.

Motor Vehicles for Business Work. M. C. Krarup. Discusses the question of economy in using motor vehicles for transportation work, summarizing the matters which should be considered when their adoption is contemplated. 5500 w. Ir Age—March 1, 1906. No. 75299.

Report on the International Exhibition of Industrial Vehicles of August, 1905 (Rapport sur le Concours Internationale de Vehicules Industriels en Aout, 1905). Georges Lumet. A detailed report of the competitive trials of the Automobile Club de France with tables and diagrams of the results. 7000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75730 G.

Lorry.

A New Steam Lorry. Illustrated description of a 40-h. p. steam lorry and its engine. 900 w. Engr, Lond—March 2. 1906. No. 75513 A.

Lucas.

A Car with a Valveless Motor. Illustrated description of a Lucas Car with its two-cycle engine and its working. 2000 w. Autocar—Feb. 24, 1906. No. 75364 A.

Motor Sleigh.

A Simple and Speedy Motor Sleigh. Brief illustrated description of a machine recently constructed at Springfield, Ohio, said to be capable of making 35 miles an hour on snow and 90 miles an hour on ice. 400 w. Sci Am—March 31, 1906. No. 75826.

Six Wheels.

Vehicles with Six Wheels (Les Voitures à Six Roues). M. Le Gaurian. A description of the compensation suspension system of Capt. Lindecker, for distributing the load upon three axles, especially adapted for heavy vehicles. 4000 w. Ann des Ponts et Chausées—4 Frimestre, 1905. No. 75779 E + F.

Specifications.

Specifications of Material Used in High-Speed Automobile and Motor-Boat Engines. Thomas J. Fay. Gives tabulated specifications of the qualities of materials used, with remarks. 900 w. Sci Am Sup—March 3, 1906. No. 75324.

Steam Wagon.

The Sentinel Steam Wagon. Illustrated detailed description of a vehicle built in Glasgow and its engine. 1600 w. Engr, Lond—March 9, 1906. No. 75607 A.

Steering.

Auto Drive, Steering and Skidding. L. M. Dieterich. A study of steering systems, with diagrams showing forces acting. 2000 w. Automobile—March 15, 1906. No. 75541.

Testing Plant.

See Mechanical Engineering, Measurement.

Trials.

Tyre, Lamp, and Speedometer Trials. An illustrated account of these interesting trials now in progress. The cars are fitted with Collier tyres of different sections, each car carrying one or two speed indicators, and one or more lamps. 1800 w. Auto Jour——March 10, 1906. No. 75582 A.

War Automobiles.

New Armored War Automobiles. Illustrates and describes new types constructed in France and Austria, reporting experiments made at the maneuvering grounds. 1500 w. Sci Am—March 17, 1906. No. 75554.

See also Mechanical Engineering, Combustion Motors.

COMBUSTION MOTORS.

Automobile Engines.

A Defect in the Motor and a Remedy. A. Gordon Ede. A proposition for increasing the power range of the engine by varying the compression. 2300 w. Autocar—March 10, 1906. Serial, 1st part. No. 75597 A.

Petrol Motors. A. Cyril Hutt. Read before the King's College Engng Soc. Considers single-cylinder motors, multi-cylinder engines, water cooling, valve gear, clutches, lubrication, carburetters, ignition, etc. Ills. 5200 w. Autocar—Feb. 10, 17, 24, 1906. 3 parts. No. 75363 each A.

Engines.

Gas, Oil and Petrol Engines. Henry N. Bickerton. Abstract of a paper before the Manchester Assn. of Engrs. Reviews present practice in these engines, and matters relating to their working, economy, etc. Discusses several types. 4000 w. Mech Engr—March 17, 1906. No. 75698 A.

Furnace Gas.

Available Power and Cost of Operation of a Power Station for Waste Gases from a Blast-Furnace Plant. H Freyn. Gives calculations assuming a new blast furnace plant of two 400-ton blast furnaces, situated in the vicinity of a large city with facilities for water supply and handling material. Discussion. 14000 w. Jour W Soc of Engrs—Feb., 1906. No. 75420 D.

Gas Engines.

New Acme High-Speed Vertical Tandem Gas Engine (Burt's Patents). Illustrated description. 1000 w. Mech Engr—March 3, 1906. No. 75496 A.

Rational Methods of Gas-Engine Powering. Sanford A. Moss. Gives general principles and rational formulas for the selection of the speed and cylinder dimensions of a gas engine to develop a given amount of power with a given fuel. Only four-cycle stationary engines are considered. 3000 w. Am Mach—Vol. 29, No. 12. No. 75642.

Some Recent Examples of the Use of Gas and Gasoline Engines in Marine Work. Illustrates and describes engines used in several vessels of diverse types. 3000 w. Eng News—March 22, 1906. No. 75648.

The Action of the Cylinder Walls of Internal-Combustion Motors (Comment s' Exerce l'Action de Paroi dans les Moteurs à Combustion Interne). L. Letombe. A study of the action of the cooling of the cylinder by water circulation, claiming that the efficiency of the engine is unaffected thereby. 4500 w. Mem Soc Ing Civ de France—Nov. 1905. No. 75727 G.

The Prime Mover of the Future. C. E. Sargent. Considers the internal combustion engine destined to be the prime mover of the future. Discusses its development, economy, etc. General discussion. Ills. 70000 w. Jour W Soc of Engrs—Feb., 1906. No. 75419 D.

Gas Producers.

Gas Producers for Power. Julius Wile. From a paper read before the Technology Club, Syracuse, N. Y. Discusses gas producers and the saving in cost, and presents the advantages of the automatic system as manufactured by the company the author represents. 2500 w. Ir Age—March 8, 1906. No. 75425.

The Gas Producer Power Plant. C. B. Lamont. Examines the results obtained at the testing plant of the St. Louis Exposition, and reviews briefly the development of the gas engine, with the aim of showing its advantage from a purely monetary standpoint, under conditions existing on the Pacific Coast. Ils. 4400 w. Jour of Elec—March, 1906. No. 75468 C.

The Suction Gas Producer. W. H. Booth. An illustrated account of the suction gas producer, its general principle and object, describing types. 3700 w. Cassier's Mag—March, 1906. Serial, 1st part. No. 75611 B.

Gas Washing.

The Bianchi Cooling and Washing Apparatus for Blast Furnace Gases (Der Bian sche Reinigungs-und Kühl-apparat für Hochofengase). Fritz Krull. The gases are passed through a drum partly filled with water, and containing revolving perforated discs. 1800 w. Glasers Annalen—March 1, 1906. No. 75724 D.

Marine Motors.

Internal-Combustion Motors for Marine Service (Motori Marini a Combustione Interna). D. Cardile. A comparative review of the applicability of various types of motors to vessels, with especial reference to the Diesel Marine motor. 5000 w. Rivisa Marittima—Jan., 1906. No. 75790 G.

The Application of Combustion Motors for the Propulsion of War Ships (Zür Frage der Verwendbarkeit von Verbrennungsmotoren für die Fortbewegung von Kriegsschiffe). Emil Capitaine. An examination of the relative weights and radius of action for steam engines, Diesel motors and Capitaine motors. Two articles. 7000 w. Schiffbau—March 14, 28, 1906. No. 75761 each D.

The Parsons Marine Motor. Illustrates and describes an internal combustion engine, specially designed for Marine work. It uses either petrol, paraffin, or alcohol as a fuel. 2000 w. Autocar—March 3, 1906. No. 75494 A.

Motor Testing.

See Mechanical Engineering, Measurement.

Oil Engine.

Oil Engine Working with Crude Oil. Illustrates and describes an engine made in England and previously described which has been adapted to the use of crude oil. 600 w. Engng——March 2, 1906. No. 75507 A.

Pressures

Experiments on Explosive Mixtures of Illuminating Gas and Air (Untersuchungen Explosibler. Leucht-gas-Luftgemische). F. Hausser. A detailed account of the investigation of pressures and associated phenomena caused by the ignition of various explosive gas mixtures in a closed chamber. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75701 D.

The Pressure of Explosives. Experiments on Solid and Gaseous Explosives. J. E. Petavel. From Phil. Trans. of the Roy. Soc. of London. An illustrated article giving detailed description of methods and of apparatus used. 3800 w. Sci Am Sup—March 24, 1906. Serial, 1st part. No. 75638.

Vaporiser.

The Westmacott Paraffin Vaporiser. Illustrated description of a vaporiser whereby ordinary lamp oil can be substituted for petrol with internal combustion engines, particularly for marine motors. 900 w. Auto Jour—Feb. 24, 1906. No. 75362 A.

HEATING AND COOLING.

Central Plant.

Reconstructing a Central Power and Heating Plant. Describes the reconstruction of a plant at Garden City, Long Island, supplying a cathedral, two school buildings, and other buildings, with the object of saving fuel. Ills. 2000 w. Heat & Vent Mag——March, 1906. No. 75-623.

Dormitories.

Some Data Relating to the Heating of the Edgar F. Smith House Dormitories, University, Pennsylvania. H. W. Spangler. The University Dormitories are a group of 21 buildings under a common roof. Describes a direct radiation system of steam heating. 2500 w. Jour Fr Inst—March, 1906. No. 75558 D.

Dwellings.

Unwholesome Air in Dwellings. Albert Levy, in *La Technique Sanitaire*. Translation. Defective heating and lighting apparatus shown to be responsible for much of the bad air. 1600 w. Heat & Vent Mag—March, 1906. No. 75625.

Fan System.

A Fan System of Furnace Heating. Illustrated description of a heating and ventilating system for an eight-room school in Summit, N. J. 2000 w. Met Work—March 24, 1906. No. 75646.

Hot Water.

Calculations and Requirements for Central-Station Heating. Discussing the Schott system for heating circulating water by exhaust steam, the hot water being distributed by circulating pumps. Ills. 2500 w. Elec Rev, N. Y.—March 24, 1906. No. 75666.

Ice-Plants.

Economy of Combination Compression—and Absorption—Plate Ice-Plants. Henry Torrence. Read before the Am. Soc. of Refrig. Engrs. Gives a comparison of the compression and absorption-systems showing that economy is gained by combining the two. 1400 w. Stevens Ind—Jan., 1906. No. 75535 D.

Refrigeration.

Rise of Temperature in Cold Stores. Reviews an article by M. Desvignes, in *L'Industrie Frigorifique,* comparing different methods employed in France for the refrigeration of insulated stores, and giving an analysis of the laws governing the loss of cold which takes place. 2000 w. Engr, Lond—March 19, 1906. No. 75604 A.

Theater.

Heating and Ventilating the New Montauk Theater, Brooklyn, New York. Illustrated description of a recent type of upward ventilation. Both direct and indirect radiation are used. 900 w. Heat & Vent Mag—March, 1906. No. 75624.

HYDRAULICS.

Hydraulic Machinery.

The Selection of Material for the Construction of Hydraulic Machinery. Arthur Falkenau. Notes on the determining factors in the selection of the materials to be used. 1800 w. Jour Fr Inst—March, 1906. No. 75557 D.

Pumping.

See Civil Engineering, Water-Supply.

Pumps.

The Centrifugal Pump and Its Application. Harry Y. Haden. Gives examples illustrating the working conditions and showing the efficiency, reporting a test on an electro-motor pump of 1200 gallons a minute capacity and 45 feet head. 1200 w. Jour of Elec—March, 1906. No. 75470 C.

The Development of the Single Steam Pump. S. J. Berard and W. C. McLeod. An illustrated article giving a general idea of the uses of various types of pumping engines, with detailed descriptions. 2200 w. Yale Sci M—March, 1906. No. 75823 C.

Pump Speeds.

The Minimum Rotative Speed of Pumps (Die Kleinste Mögliche Umlaufzahl von Pumpwerken). G. Goldstein. Discussing especially fly-wheel pumps and comparing the computed minimum speeds with those observed in practice. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1906. No. 75703 D.

Turbines.

Pressures in the Rotating Mass of Water and Axial Thrust in a Francis Turbine with Horizontal Shaft (Die Drückverhältnisse in einer um eine Horizontale Achse Rotierenden Wassermasse undder Achsiale Schub bei Francis Turbinen mit Liegender Wolle). Dr. Karl Kobes. An analytical and graphical examination of the pressures in unbalanced horizontal turbines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 1906. No. 75734 D.

Water Meters.

See Civil Engineering, Measurement.

MACHINE WORKS AND FOUNDRIES

Axle Factory.

Methods of a Modern Vehicle-Axle Plant. Charles A. Trask. Illustrated detailed description of methods in use at a plant in Jackson, Michigan. 2500 w. Am Mach—Vol. 29, No. 12. No. 75641.

Band-Saw.

Electrically-Driven Band-Saw for Metal. Illustrations, with short description. 500 w. Engng—March 16, 1906. No. 75806 A.

Bearings.

Ball and Roller Bearings. Henry Hess. Abstracted from the discussion on bearings at the N. Y. meeting of the A. S. M. E. A brief review. Ills. 2200 w Am Mach—Vol. 29, No. 11. No. 75520.

The Performance of a Large Experimental Bearing. Albert Kingsbury. A contribution to the discussion at the Dec., 1905, meeting of the A. S. M. E. Illustrated account of tests made by the Westinghouse Electric and Manufacturing Co., at the East Pittsburg Works. 1000 w. Am Mach—Vol. 29, No. 11. No. 75519.

Boring Mill.

Designing a Boring Mill. Gives the reasoning of the author in preparing a design for a boring mill of 6 feet swing to take 48 inches under the cross rail. Ills. 3500 w. Am Mach—Vol. 29, No. 10. No. 75426.

Cams.

Notes on the Cam Chart. John Roy. On the laying out of cam charts, with a comparison with article published by C. F. Smith. 1500 w. Am Mach—Vol. 29, No. 11. No. 75517.

Cores.

Core Oil and Oil Cores. W. P. Henemann. An illustrated article discussing the making of cores. Foundry—March, 1906. No. 75422.

Principles and Practice of Coremaking. Robert Buchanan. Abstract of a paper read before the Staffordshire Iron & Steel Inst. Discussing core boxes, cores, and core-making, rods, venting, drying, loam cores, etc. 4500 w. Ir & Coal Trds Rev—March 9, 1906. No. 75595 A.

Cupolas.

Distribution of Blast in Modern Cupola Practice. William H. Coleman. Aims to show the effects of high and low pressures on the melting capacities of cupolas, and on the cupola itself, as well as on the product. 1500 w. Ir. Trd Rev—March 29, 1906. 75838.

Drafting.

Shop Hints for Structural Draftsmen. John C. Moses. The present article considers the templet shop and discusses the possible saving of expense. Ills. 3000 w. Eng News—March 22, 1906. Serial, 1st part. No. 75649.

Drawing Presses.

Progress in the Construction of Drawing Presses (Fortschritte im Räderziehpresenbau). Karl Musiol. An examination of cam roller drawing presses, showing the influence of the elasticity of the machine parts upon its action. Serial, Part I. 2500 w. Stahl u Eisen—March 1, 1906. No. 75744 D.

Electric Driving.

Electric Driving in Shipyards. Illustrates and describes interesting installations at Sunderland, England, for driving machine tools. 1600 w. Engr, Lond—March 2, 1906. No. 75514 A.

Electricity in the Foundry. H. S. Knowlton. An illustrated article calling attention to the variety of uses to which electricity has been applied in the foundry. 1500 w. Cassier's Mag—March, 1906. No. 75609 B.

Some Notes on Motor Driving. W. J. Belsey. Describes some novel applications of motor driving and considers the type of motor most suitable for the operation of various machines. Ills. 3000 w. Elec Engr, Lond—Feb. 23, 1906. Serial, 1st part. No. 75369 A.

See also Mining and Metallurgy, Iron and Steel.

Foundry.

A Puzzling Bit of Foundry Work. C. Metcalf. An illustrated description of the making of a double-grooved drum, at iron works in South Brooklyn. 1000 w. Sci Am—March 31, 1906. No. 75827.

Foundry Practice. William A Bole. Abstract of a paper read before the Pittsburgh Found. Assn. Discusses the use of scrap requirements of castings, bad castings, flasks and outfit. 5500 w. Foundry—March, 1906. No. 75421.

Gear Cutting.

The Bevel-Gear Cutting Machine of Ducommun at Mulhouse in Alsace (Die Kegelrad hobelmaschime der Werk-stätte für Maschinenbau un vorm. Ducommun in Mülhausen). Hermann Fischer. Describing a bevel-gear cutting machine on the Bilgram principle, developing the theoretical form of tooth as it is cut. 1500 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75710 D.

Molding.

Foundry Molds and Their Production. E. L. Rhead. Considers green sand moulds, dry sand moulds, loam moulds, and moulding operations. 3500 w. Mech Engr—March 10, 1906. No. 75585 A.

Molding Sand. H. E. Field. Read before the Pittsburgh Found. Assn. Considers the materials which make a good molding sand, and the properties that are desirable. 2800 w. Ir Age—March 15, 1906. No. 75516.

The Moulding of Bulky Pieces in a Contracted Space (Knapper-Raum—Sperrige Stücke). J. Leber. Describing the molding of a large flywheel with grooves for rope driving, the run being swept up in the sand. 1800 w. Stahl u Eisen—March 1, 1906. No. 75745 D.

Molding Machine.

The "Leeds" Hand-Press Molding-Machine. Illustrated description of the machine and method of making molds. 1200 w. Engng—Feb. 23, 1906. No. 75374 A.

Pipe.

Concerning Steel Pipe. Extracts from a paper by Frank N. Speller, published in the *Journal* of the Canadian Mining Inst. Considers the corrosion, and the threading. 2200 w. Locomotive—Jan. 1, 1906. No. 75537.

Pistons.

Experiments upon the Strength and Deflection of Pistons (Versuche zur Ermittelung der Durchbiegung und der Widerstandsfähigkeit von Scheibenkolben). C. Bach. A description of experimental apparatus for determining the actual deflection of pistons under pressure. 1200 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75711 D.

Shop Methods.

New Shop Methods from the Machinist's Point of View. W. Burns. The influence of modern shop methods upon the training of the all-round mechanic, and the future of the individual workman. 2000 w. Engineering Magazine—April, 1906. No. 75789 B.

Shops.

A Large and Well Designed Crane Shop. Illustrated detailed description of a plant at Milwaukee, Wis. 2800 w. Ir Trd Rev—March 1, 1906. No. 75313.

The Shops and Some of the Methods of the Norton Grinding Company. Illustrates and describes new shops in Worcester, Mass., and the methods employed.

4200 w. Am Mach—Vol. 29, No. 9. No. 75301.

See also Railway Engineering, Permanent Way and Buildings.

Threading Devices.

An Opening Taper-Threading Die and a Collapsing Pipe-Tap. Illustrated description of interesting devices, with explanation of their use. 1000 w. Am Mach—Vol. 29, No. 11. No. 75518.

Turret Lathes.

Complete Scheme for Turret Lathe Fixture with Special Set of Tools. C. V. Raper. Gives operations and tool lists, with illustrations of the samples of finished work. 1000 w. Mach, N. Y.—March, 1906. No. 75237 C.

Valve.

A Nine-Foot Valve. Robert Shirley. Illustrates and describes the method of making the pattern and mold for these valves. 1500 w. Foundry—March, 1906. No. 75423.

Welding.

The Autogenous Welding of Metals (La Soudure Autogene des Metaux). P. Dumesnil. A study of the practical use of the oxy-hydrogen and oxy-acetylene blow pipes; with an examination of the thermal reactions, and data as to cost of operation. 6000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75726 G.

MATERIALS OF CONSTRUCTION

Alloys.

Iron-Carbon Alloys with High Percentages of Carbon. F. Wust in *Metallurgie*. Translation. An experimental study, giving analyses, micro-photographs and cooling curves and discussing results. 3000 w. Ir & St Mag—March, 1906. No. 75630 D.

Valuable Alloys. Translated from Krupp *"Die Legierungen."* Information concerning the constituents and properties of a number of alloys. 2700 w. Sci Am Sup—March 17, 1906. No. 75556.

Fatigue.

Season-Cracking of Brass and Bronze Tubing. Edwin S. Sperry. From *The Brass World*. Considers the fatigue of the metal to be the cause of the season-cracks, and that hydraulic drawing-benches cause this condition. 2500 w. Mech Engr—March 10, 1906. No. 75584 A.

Lubricants.

The Engineering Value of Lubricating Oils. William F. Parish, Jr. Abstract of a paper read before the N. E. Coast Inst. of Engrs. & Shipbldrs. Reports a comparative power test made by experts, and gives other information in regard to lubrication. 2500 w. Ir & Coal Trds Rev—March 16, 1906. No. 75810 A.

Manganese-Bronze.

Manganese Bronze and Its Manufacture. Abstract from an article by Edwin S. Sperry in *The Brass World*. Gives the history, theory, analysis, etc. 3000 w. Sci Am Sup—March 31, 1906. No. 75829.

Metals.

The Internal Architecture of Metals. Editorial review of a lecture by Prof. J. O. Arnold, before the Royal Institution. 1500 w. Engng—March 2, 1906. No. 75509 A.

Tool Steels.

Tests of High-Speed Tool Steels on Cast Iron. L. P. Breckenridge and Henry B. Dirks. Description, with illustrations, of experiments made in the shops at the University of Illinois. 3300 w. Am Mach—Vol. 29, No. 10. No. 75427.

MEASUREMENT

Accelerometers.

Acceleration and Accelerometers. A. P. Trotter. Read at the Junior Inst. of Engrs. Explains the principle of the accelerometer and its behavior. 3000 w. Engng—March 9, 1906. No. 75602A..

Automobile Testing.

A Modern Testing Plant for Gasoline Automobile Motors. Dr. Alfred Gradenwitz. Brief illustrated description of a testing plant in Berlin. 700 w. Sci. Am. Sup—March 3, 1906. No. 75323.

Measuring Power at the Road Wheels. Illustrates and describes the testing plant at Purdue University at Lafayette, Indiana, its construction and action. 2200 w. Auto Jour—March 3, 1906. No. 75493A.

Centrifugal Force.

Experiments on the Strength of Rotating Disks (Versuche über die Festigkeit Rotierender Scheiben). M. Grubler. An account of the continuation of the author's experiments to determine the bursting speeds of emery wheels and similar disks 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75706 D.

Curves.

The Holbrook Spiral Curve. Prof. W. D. Taylor. Reprinted account of the properties of this curve and of its use. 1000 w. Wis Engr—Feb., 1906. No. 75311 D.

Dynamometer.

Bailey's Dynamometer. Brief Illustrated description of a design that will indicate automatically the number of revolutions, and the weight or degree of resistance. 400 w Mech Engr — March 17, 1906. No. 75697 A.

Flexure.

A Complete Analysis of General Flexure in a Straight Bar of Uniform Cross-Section. L. J. Johnson. States the problem and gives the solution. 7000 w. 1 plate. Prs Am Soc of Civ Engrs—Feb., 1906. No. 75341 E.

Impact.

Collision, Direct and Oblique, With and Without Friction. Robert H. Smith. The present number is a study of "normal central impact" which produces no tangential force and no spinning in the masses. 2500 w. Engr, Lond—Feb. 23, 1906. Serial, 1st part. No. 75377 A.

Indicator.

An Improved Stress-Strain Indicator. Describes the action of an ingenious instrument, recently patented by A. Suggate, which is capable of measuring stresses of any kind in any material that is undergoing a strain. 2000 w. Prac Engr—March 2, 1906. No. 75495 A.

Standards.

Standards of Length. Herbert T. Wade. Information concerning the two meter bars in the custody of the National Bureau of Standards at Washington, and the care given them. Also the uses to which they are applied. Ills. 1200 w. Sci Am—March 10, 1906. No. 75429.

POWER AND TRANSMISSION

Air-Compressors.

An Air-Compressor Test. John Howatt. Summary of a test made at Oelwein, Iowa. 900 w. Eng & Min Jour—March 24, 1906. No. 75662.

Elevator Equipment.

The Electrical Equipment of a Two-Million-Bushel Grain Elevator. Illustrates and describes the equipment of the operating elevator at Weehawken, N. J., belonging to the N. Y. C. & H. R. R. R. 1400 w. Elec Rev, N Y—March 17, 1906. No. 75560.

Regulation.

The Influence of Elastic Connections upon the Regulation of Rotating Motors (Die Elastische Verbindung der Rotierenden Massen und ihr Einfluss auf den Reguliervorgang des Motors.) Philipp Ehrlich. A discussion of the mechanical problems of speed regulation, showing the influence of the torsional elasticity of shafts, couplings, etc., upon the regulation of heavy machinery. 4500 w. Zeitschr d Oesteri Ing u Arch Vei—March 9, 1906. No. 75736 D.

STEAM ENGINEERING.

Boiler Explosion.

The Boiler Explosion on the "Bennington." An account of the accident which occurred July 21, 1905, on the Pacific Coast. Also reviews the investigation of the cause as given in the Report of the Court of Inquiry. 3300 w. Locomotive—Jan., 1906. No. 75538.

Boilers.

Boiler Efficiency Tests. George T. Hanchett. Describes methods of making these tests, which the writer has found convenient. 2500 w. Elec Wld—March 3, 1906. No. 75355.

Large Locomotive Boilers. G. J. Churchward. Gives 16 plates of boiler designs, with a short paper discussing recent improvements and present practice. 2500 w. Inst of Mech Engrs—Feb. 16, 1906. No. 75308 D.

Corrosion.

Corrosion and Its Effects in Steam Boilers. William H. Fowler. The present number considers the corrosion of external surfaces. Ills. 1000 w. Mech Engr—March 10, 1906. Serial, 1st part. No. 75583 A.

Fuel Oil.

Burning Fuel Oil. J. E. Anderan. An Illustrated description of a fuel oil system for a 300-h. p. plant, built to comply with the insurance rules. 1200 w. Engr, U S A—March 1, 1906. No. 75336 C.

Fuel Value.

The Fuel Value of Some Tennessee and Kentucky Coals. Charles A. Ferris. A description of the Parr Calorimeter and the results obtained in using it. 1400 w. Mines & Min—March, 1906. No. 75452 C.

Governors.

The Action of Governors. E. E. Russell. Gives analysis of the action of a governor, and explains the principle of the flyball governor. Ills. 1000 w. Engr, U S A—March 1, 1906. No. 75335 C.

Mechanical Draught.

The Conditions of Mechanical Draught Production. Walter B. Snow. Discusses the economy, methods of application, losses, efficiency, &c. 3800 w. Cassier's Mag—March, 1906. No. 75610 B.

Portable Engines.

The Development of the Wolf Portable Engine (Die Entwicklung der Lokomobilen von R. Wolf). Karl Heilman. A review of the growth of the portable and semi-portable engine and boiler, to the production of the modern compound type, using superheated steam and giving maximum efficiency. Serial, Part I. 3500 w. Zeitschr d Ver Deutscher Ing—March 3, 1906. No 75708 D.

Smoke.

Smoke Prevention in the Modern Power Station. John B. C. Kershaw. Discusses means of improving the efficiency of the boiler plants. 2500 w. Power—March, 1906. No. 75382 C.

Steam Accumulator.

The Rateau System for the Utilization of Exhaust Steam from Engines of Intermittent Action (Das Rateausche Verfahren Zur Verwertung des Abdampfes von Maschinen mit unter brochenam Betrieb). A. Heller. An account of the application of the Rateau accumulator and low-pressure steam turbine to the utilization of exhaust steam. 2500 w. Zeitschr d Ver Deutscher Ing—March 10, 1906. No. 75709 D.

Steam Turbines.

Installation of a Low-Pressure Steam Turbine. An illustrated description of the conditions, and the plan so far as worked out, for the installation of a 500-K. W. low-pressure, direct-current turbine-driven unit in a power house near Scranton, Pa. 800 w. Power—March, 1906. No. 75383 C.

Steam Turbines. W. H. Booth. Remarks on trouble with the blades of steam turbines, due chiefly to the stripping-out of blades under the influence of something deleterious to them, discussing the cause. 1400 w. Elec Rev, Lond—March 2, 1906. No. 75500 A.

Test on a 1500 K. W. Curtis Turbine. Reports steam consumption tests on a Curtis turbo-alternator set running at the electricity works of the County of London Electric Supply Co. 700 w. Elect'n, Lond—March 2, 1906. No. 75502 A.

The Effect of Admission Pressure on the Economy of Steam Turbines. T. Stevens and H. M. Hobart. An examination of the results of tests on steam-turbines of the Parsons type, giving curves and tables. 3300 w. Engng—March 2, 1906. Serial, 1st part. No. 75510 A.

Superheating.

Can Superheated Steam Contain Water? (Beitrag zur Frage: Kann übernitzer Dampf Wasser Enthalten?) Fritz L. Richter. Data and results of experimental investigations, showing that entrained water cannot exist in pipes in which the steam is superheated 30 degrees C. above saturation temperature. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1906. No. 75705 D.

Notes on Superheated Steam. J. R. Bibbins. Discusses important things in order to determine the ultimate commercial value of superheat. 2500 w. Elec Jour—March, 1906. No. 75628.

Valves.

Development of Valves and Valve Motion. Angus Sinclair. An illustrated article reviewing the history of steam engine valves and describing types. 4000 w. Ry & Loc Engng—March, 1906. Serial. Part I. No. 75487 C.

MISCELLANY.

Aeronautics.

Count von Zeppelin's Dirigible Airship. Reviews the experiments with this airship, and gives an illustrated description of improvements recently introduced. 1300 w. Sci Am—March 3, 1906. No. 75321.

Some Recent Foreign Flying Machines. Illustrates and describes some of the latest attempts at solving the problem of flight. 1700 w. Sci Am.—March, 1906. No. 75636.

Oxygen.

The Use of Liquid Air in the Manufacture of Oxygen and Nitrogen (La Liquéfaction de l'Air et ses Applications à la Fabrication Industrielle de l'Oxygène et de l'Azote). Georges Claude. A detailed account of the commercial production of oxygen as now actually conducted in France, by the rectification of liquid air. 7000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75729 G.

MINING AND METALLURGY

COAL AND COKE

Anthracite.

Virginia Anthracite Field. J. E. Tiffany. Describes a region showing coal formations, the values of which have not yet been thoroughly proved by prospecting. 3500 w. Mines & Min—March, 1906. No. 75455 C.

Coal Cutting.

Tubular Drills for Coal Cutting (Bohr und Schrämmaschine mit Kernbohrwerkzeug). Dr. Tùbben. Describing the successful use of core drills for coal cutting in the Friedrichsthal mine at Saarbrück. 1800 w. Glückauf—Feb. 24, 1906. No. 75737 B.

Coal Tips.

New Coal Tips at Garston Docks. Illustrates and describes two powerful hydraulic coal tips for the London and North-Western Railway Company, erected near Liverpool. 700 w. Engr. Lond—March 16, 1906. No. 75803 A.

Coal Trade.

See Industrial Economy.

Disaster.

Explosion at Courrieres Colliery. An account of the terrible disaster in France on March 10, 1906. 2200 w. Col Guard—March 16, 1906. No. 75696 A.

The Coal Disaster in France. Donald F. Campbell. An illuustrated article briefly describing the Pas de Calais mines and their equipment, where a disaster costing over 1200 lives, recently occurred. 1000 w. Min & Sci Pr—March 17, 1906. No. 75673.

Electrical Plant.

How to Avoid Accidents with Electrical Machinery in Coal Mines. H. Morton Middleton. Aims to show that if care is taken with the selection and installation of the plant, and it is given intelligent supervision, it will prove the safest and most economical form of power that can be used in a colliery. 3500 w. Col Guard—March 16, 1906. No. 75695 A.

National Mining Company's Mines. Illustrated description of coal mines where electricity is applied to nearly every purpose below or above ground, and chain hauls are used in the main slope. 2000 w. Eng & Min Jour—March 10, 1906. No. 75461.

Filling.

The Hydraulic Filling of a Coalseam at Lens, Pas-de-Calais, France. Lionel E. Hill and Malcolm Burr. Abstract of a paper read before the Inst. of Min. and Met. Describes the process as applied at the colliery named. Ills. 2000 w. Col Guard—March 2, 1906. No. 75505 A.

Lancashire.

Half a Century of Lancashire Coal Mining. Jno. Unsworth. Read before the Nat. Assn. of Colliery Mgrs. A review of mining conditions, production, accidents, wages, legislation, improvements, &c. 9500 w. Ir & Coal Trds Rev—March 16, 1906. No. 75809 A.

Operation.

The Operation of a Coal Mine. Thomas A. Jackson. Discusses the essential principles in regard to production, transportation and preparation of the coal. 3500 w. Mines & Min—March, 1906. No. 75459 C.

The Springfield Coal Mine of the Peabody Coal Co., and the Method of Survey. Mr. F. Peltier. Abstract of a paper read at meeting of the Illinois Soc. of Engrs. & Survs. Describes this modern coal mining plant in Illinois. 1500 w. Eng News—March 8, 1906. No. 75437.

Workings.

Late Methods of Rib Drawing. Elias Phillips. Read before the Coal Min. Inst. of America, at Pittsburg, Pa. Illustrates and describes improved methods applied in the Connellsville seam, discussing the importance of taking out a large percentage of coal. 3200 w. Mines & Min—March, 1906. No. 75460 C.

COPPER

Copper.

The Reign of Copper. Percy E. Barbour. Part I gives an historical review of the uses made of copper from the earliest times, and its commercial importance. Part II gives information of the copper mining districts of the United States. 5000 w. Jour Worcester Poly Inst—March, 1906. No. 75515 C.

Crushing.

Gigantic Crushing of Copper Ore. A. S. Atkinson. Report of the steam stamp of 700 tons per day capacity, and of other methods of crushing in the Lake Superior region. 2500 w. Mines & Min—March, 1906. No. 75453 C.

Smelting.

Pyrite Smelting Without Coke. Lewis T. Wright. On the extraction of copper from cupriferous pyrite, reviewing the English method, and giving an account of results obtained by the writer. 3000 w. Min & Sci Pr—Feb. 24, 1906. No. 75327.

GOLD AND SILVER

Assaying.

Notes on Gold Assay Methods (Beiträge zum Goldprobierverfahren). Leopold Schneider. A review of the development of assaying processes for the separation of gold, with especial reference to silver and lead alloys. Two articles. 5000 w. Oestern Zeitschr f Berg u Hüttenwesen—Feb. 17, 24, 1906. No. 75738 each D.

British Columbia.

Progress of Mining in the Similkameen District. George E. Winkler. Briefly reviews the mining history of this gold and copper region, describing especially the progress during the year 1905. 3000 w. B. C. Min Rec—Jan., 1906. Serial. 1st part. No. 75312 B.

Cobalt.

Cobalt. D'Arcy Weatherbe. Information concerning the silver-nickel-cobalt mine in Ontario, Canada. 2500 w. Min & Sci Pr—March 10, 1906. No. 75563.

Comstock.

The Comstock in 1876. View of Virginia City as it looked thirty years ago, with interesting review of its noted gold and silver mine. 2500 w. Min & Sci Pr—Feb. 24, 1906. No. 75326.

Concentration.

The Baggaley Pyritic - Conversion Process. Describes this process which is designed to effect the concentration of any kind of copper, gold, or silver ore. 3500 w. Eng & Min Jour—March 24, 1906. No. 75663.

The Cactus Mill at Newhouse, Utah. Illustrates and describes a modern concentrating plant of one thousand tons daily capacity. 3300 w. Mines & Min—March, 1906. No. 75449 C.

Cyanide.

Modern Cyanide Plants. John E. Rothwell. Concerning the improvements recently introduced in the arrangement and operation of cyanide plants. 2000 w. Min Wld—March 24, 1906. No. 75675.

Dumps.

A Proposed Method of Treating Sand Residue Dumps. S. J. Truscott and A. Yates. Outlines the proposed scheme of treatment. 1000 w. Jour Chem, Met & Min Soc of S. Africa—Jan., 1906. No. 75596 E.

Gold.

Gold and Its Chemistry. G. T. Beilby. Abstract of an address before the S. African meeting of the Brit. Assn. for the Adv. of Science. The influence of iron and of gold upon the world's progress is discussed, and the chemical development of metallurgy and its application to gold recovery. 1800 w. Sci Am Sup—March 10, 1906. No. 75431.

Guiana.

Notes on Dutch Guiana. E. H. Teats. Information concerning the geography, mining laws, auriferous deposits, etc. Ills. 3000 w. Eng & Min Jour—March 24, 1906. No. 75661.

Mexico.

Mining in Western Chihuahua. W. Spencer Hutchinson. An illustrated account of the mines of this region, the gold value being the most important, although silver is also found and other minerals of value. 1200 w. Eng and Min Jour—March 3, 1906. No. 75334.

Ore Deposits.

The Pribram Ore Deposits (Neues über das Pribramer Erzvorkommen). A. Hofmann. Discussing the recent developments of silver bearing galena in the Pribram mining district of Bohemia. 2000 w. Oesterr zeitschr f Berg u Hüttenwesen—March 10, 1906. No. 75741 D.

Placers.

Giant Hydraulic Placer Mining in Oregon. A. S. Atkinson. Explains the great difficulties encountered in working high elevations, and describes the pumping of water with turbines against a head of 430 feet for operating giant nozzles. 1700 w. Mines & Min—March, 1906. No. 75454 C.

Soudan.

Ancient Gold Fields of the Soudan. T. Buxton. Information concerning these old mines and the methods used in working them. 1500 w. Min Jour—Feb. 24, 1906. No. 75370 A.

Stamp-Milling.

Stamp-Milling in Northern California. Algernon Del Mar. Describes a series of tests at the Edel mill, discussing the results. Ills. 2200 w. Min & Sci Pr—March 3, 1906. No. 75445.

Wyoming.

Mineral Resources of Northeastern Wyoming. A statement of the mineral resources of Crook County, Wyoming, in the vicinity of Sundance. Gold, copper, silver, lead, coal, gypsum, bentonite, and limestone are found. 2500 w. Min Rept—March 22, 1906. No. 75671.

IRON AND STEEL

Blast Furnaces.

A Graphic Method for the Computation of Blast Furnace Charges. C. O. Bannister. From *Trans. of Inst. of Min. & Met.* Explains the preparation of the diagram and gives an example of the calculation, and of the method of regulating the charge from the analysis of the slag produced. 600 w. Ir & St Mag—March, 1906. No. 75631 D.

Technical Progress in Blast-Furnace Practice (Technische Fortschritte im Hochofenwesen) Oskar Simmersbach. Discussing the briquetting of iron ores, the use of mechanical conveyors and handling apparatus, and the general development of mechanical appliances. Serial, Part I. 3500 w. Stahl u Eisen—March 1, 1906. No. 75743 D.

Dry Blast.

New Developments in Dry Blast. A Steinbart. Read before the Technische Verein, Pittsburg. Refers to results obtained by Mr. James Gayley, and the theory of Mr. J. E. Johnson, giving also the writer's reason why there is in a dry blast furnace less heat necessary, per pound of iron made, for reactions below the critical temperature. 1800 w. Ir Trd Rev—March 15, 1906. No. 75540.

Electric Smelting.

The Development of the Electric Smelting of Iron and Steel (Die Weitere Entwicklung der Elektrischen Verfahren zur Herstellung von Eisen und Stahl). Dr. Albert Neuburger. A review of recent progress with especial reference to the work of Kjellin, Schneider, and Gin. 5000 w. Glasers Annalen—March 15, 1906. No. 75752 D.

Iron Ore.

The Northern Iron Fields. M. P. Youngs. Information concerning the ore traffic on the Minnesota railroads, the development work in progress, etc. 2000 w. Min Wld—March 3, 1906. No. 75350.

Re-Rolling.

The Works of the English McKenna Process Company. Describing the new plant at Birkenhead for re-rolling old and worn rails; including grinding machinery, heating furnaces, rolling mills, and general mechanical equipment. 3000 w. Engn'g—March 2, 1906. Serial, Part I. No. 75506 A.

Rolling Mills.

Methods of Driving Rolling Mills. A comparison of the effectiveness of steam power and electric motors for driving rolling mills, advocating electric driving, with gas engines as prime movers. Abstract from paper by H. Ortman in *Stahl und Eisen.* 2800 w. Ir Age—March 8, 1906. No. 75424.

The Large Wire-Rod Rolling Mills of The Phoenix Works at Hamm. Westphalia (Die Grosse Drahtstrasse der A. G. Phoenix zu Hamm i. w.) with plan of the mill, and illustrated description of the triple-expansion engines of 2000 h. p.

2000 w. 2 plates. Stahl u Eisen—March 1, 1906. No. 76742 D.

Separators.

Magnetic Separators (Les Séparateurs Magnétiques). L. Fabre. Illustrated description of various types of machines for separating magnetic ores from rock, sand, and other impurities. Two articles. 3000 w. L'Electricien—Feb. 17, 24, 1906. No. 75766 Each B.

MINING.

Cages.

Cage and Landing Chairs. R. D. O. Johnson. Describing the drop-bottom type of cage for use in deep mine hoists. The movable portion of the cage bottom holds the car securely during transit, and, with the accompanying landing chair, permits prompt unloading. Ill. 1400 w. Eng & Min Jour—March 3, 1906. No. 75333.

Camps.

The Beginning of a Mining Camp. Prof. Arthur Lakes. Describes the starting point of a typical rough camp in the west. Ills. 1300 w. Mines & Min. March, 1906. No. 75450 C.

Drills.

Air-Hammer Rock-Drills. Edward A. Rix. Abstract of a paper before the California Miners' Convention, on the advantages of these drills. 2800 w. Min & Sci Pr—Feb. 24, 1906. No. 75329.

Electric Power.

Electricity at European Oil Wells. George E. Walsh. The dangers of present methods are discussed, and the avoiding them by installation of central stations and electric transmission. 2500 w. Mines & Min—March, 1906. No. 75457 C.

The Use of Electricity in Mines. R. G. Mercer. Abstract of a paper read before the Birmingham and District Electric Club. Considers its application to winding, haulage, pumping, coal-cutting, etc., discussing the distribution, systems, and economy. 3500 w. Elect'n, Lond—March 16, 1906. No. 75681 A.

Fans.

The largest Fan in Existence. Report some tests made at the Ronco mine, in Fayette Co., Pennsylvania, comparing with another large fan in regard to volume, size, and efficiency. Ills. 800 w. Mines & Min—March, 1906. No. 75456 C.

Faults.

Classification of Faults and Fractures into Series and Sets, and Its Practical Application. F. Julius Fohs. Abstracted from forthcoming reports on the deposits of western Kentucky. 1500 w. Eng & Min Jour—March 24, 1906. No 75660.

Hoisting.

Hoisting Methods at Butte. A. H. Wethey. An illustrated article giving the results of 18 years experience with hoisting in the mines of W. A. Clark, at Butte, Mon. 1500 w. Eng & Min Jour—March 10, 1906. No. 75462.

Tests upon the Weakening of Hoist-Cables from Broken Wires (Versuche über die Unsichere Drahtlänge bei Drahtbrüchen in Förderseilen) Hermann Kroen. Detailed report of tests of wire rope cables to ascertain the effect of the breaking of isolated wires. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 3, 1906. No. 75740 D.

Hydraulic Mining.

The Control of Hydraulic Mining in California by the Federal Government. William W. Harts. Explains the débris problem, describing the mining region and methods, the duties of the Commission, the general principles of improvement, etc. Ill. 11500 w. Pro Am Soc of Civ Engrs—Feb., 1906. No. 75342 E.

Ladders.

Making Mine Ladders. Matt. W. Alderson. Remarks on the requirements of mine ladders, with illustrations of types. 1200 w. Min & Sci Pr—Feb. 24, 1906. No. 75328.

Mining Law.

The Grand Central—Mammoth Decision. Describes the mines in dispute and reviews the second trial in the present number. 4300 w. Min & Sci Pr—Jan. 31, 1906. Serial, 1st part. No. 75562.

Ore Deposits.

The Genesis of Ore Deposits. C. O. G. Larcombe. Lecture before the Science Society of Sydney University, giving an explanation and comparison of recent theories. 4000 w. Aust Min Stand—March 10, 1906. Serial, 1st part. No. 75360 B.

Roasting.

Theoretical Aspects of Lead-Ore Roasting. C. Guillemain. Abstract translation from *Metallurgie*. Refers to some new processes of lead-ore roasting. The methods of Antouin Germot and of Huntington and Heberlein. 2200 w. Eng & Min Jour—March 10, 1906. No. 75464.

Safety Catches.

A Critical Examination of the Action of Safety Catches (Kritische Besprechung Gefährlicher Fall und Fangergebnisse). H. Undeutsch. An examination of the construction of safety catches on mine hoists, with especial reference to the permissible amount of drop before seizure. Two articles. 5000 w. Osterr Zeitschr f Berg u Hüttenwesen—March 3, 10, 1906. No. 75739 each D.

Screening.

A Traveling-Belt Screen. Illustrated description of this machine explaining the fundamental principle. 1800 w. Eng & Min Jour—March 10, 1906. No. 75463.

Shafts.

Allan Shafts. H. S. Patterson. Illustrated description of the progress in sinking and the methods employed at two shafts of the Acadia Coal Company, Nova Scotia. 900 w. Mines & Min—March, 1906. No. 75451 C.

Improved Shaft Equipment. S A. Worcester. Illustrates and describes an arrangement designed for handling ore at the Golden Cycle mine, Cripple Creek, Colo. It is claimed that it will save from $8 to $15 each 8-hour shift. 1500 w. Min & Sci Pr—March 17, 1906. No. 75672.

Sinking, Development and Underground Equipment of Deep Level Shafts on the Rand. Arthur E. Pettit. Read before the Inst. of Min. & Met. An illustrated description of methods of sinking and equipping shafts, with some figures relating to the cost. 4500 w. Ir & Coal Trds Rev—Feb. 23, 1906. Serial. 1st part. No. 73379 A.

Sinking Shafts for a Modern Colliery. Prof. F. W. Hardwick. The present lecture is confined to the sinking of shafts and the difficulties encountered. 10500 w. Jr & Coal Trds Rev—March 2, 1906. No. 75515 A.

Winding.

Electric Winding in Main Shafts Considered Practically and Commercially. W. C. Mountain. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Briefly considers the systems of winding, especially from a commercial standpoint. Does not favor electricity for heavy winding. 2500 w. Col Guard—Feb. 23, 1906. No. 75371 A.

Weight in Winding Drums. R. H. Collingham. Considers the weight of a conical drum with regard to the weight of a parallel drum of the same maximum diameter. Gives method used by writer. 1800 w. Engr, Lond—Feb. 23, 1906. No. 75376 A.

MISCELLANY.

Asbestos.

Concerning Asbestos. George P. Merrill. Gives a brief resume of the physical and chemical properties of the four varieties of asbestos on the market, the localities and mode of occurrence. 1500 w. Min Wld—March 24, 1906. No. 75676.

Distillation.

The Boiling and Distillation of Nickel Iron, Manganese, Chromium, Molybdenum, Tungsten and Uranium (Sur l'Ebullition et la Distillation du Nickel, du Fer, du Manganèse, du Chrome, du Molybdène, du Tungstène, el de l'Uranium). Henri Moissan. A study of the behaviour of the metals of the iron group in the electric furnace. 3500 w. Comptes Rendus—Feb. 19, 1906. No. 75720 D.

Platinum.

Researches on Metals of Platinum Groups. Prof. Henri Moissan. Paper read at Académie des Sciences. Gives experiments made with the ordinary form of Moissan furnace. 1500 w. Sci Am Sup—March 31, 1906. No. 75830.

Tungsten.

Tungsten Ore in Washington. M. H. Joseph. An account of the discovery. 700 w. Eng & Min Jour—March 3, 1906. No. 75332.

Uranium.

Uranium: Its Preparation, Gravimetric Determination and Occurrence, Victor Blanc. From the Trans. of W. Assn. of Tech. Chem. and Met. Information concerning the discovery, appearance, determination, uses, etc. 2000 w. Min Wld—March 10, 1906. No. 75475.

Zinc.

The Wisconsin Zinc District. H. A. Wheeler. Describes an old lead and zinc producing district which modern machinery and methods have rendered profitable. Map. 6000 w. Mines & Min—March, 1906. No. 75458 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Accident.

The Catesby Tunnel Accident. An account of the accident occurring last Jan. on the Great Central Railway. 1500 w. Engng—March 16, 1906. No. 75807 A.

Competition.

Competition Between Railway and River Transportation in the Early Part of the Railway Era: A Leaf from the History of the Hudson River R. R. Extract from an interesting paper by J. B. Jarvis, written in 1850, regarding the cost of transportation at that time. 4500 w. Eng News—March 22, 1906. No. 75651.

Train Dispatching.

See Street and Electric Railways.

Train Service.

How to Improve Passenger Service. R. Marpole. A paper (condensed) presented at a Canadian Pacific officers' conference at Field, B. C. Briefly considers the track, the equipment and care of passenger trains, and the manning of the trains with capable men. 200 w. R R Gaz—Vol. XL., No. 10. No 75.444.

MOTIVE POWER AND EQUIPMENT.

Acceleration.

Energy Expended on Car-Wheel Acceleration. A study explaining the method of calculation. 1000 w. Engng—March 9, 1906. No. 75599 A.

Air Brakes.

The New Westinghouse "K" Triple Valve. States the advantages and describes the action, giving information concerning its special features. Ill. 2500 w. R R Gaz—Vol. XL., No. 12. No. 75645.

Boilers.

See Mechanical Engineering, Steam Engineering.

Car Design.

Science Applied to Car Design. Illustrates and describes new features introduced in the Sullivan side-door car, used in suburban traffic on the Illinois Central Railroad. 1500 w. Ry & Loc Engng—March, 1906. No. 75489 C.

Car Hygiene.

Hygeine as Applied to Railway Coaches. Dr. J. M. Gassaway. Discusses the danger of infection, reporting tests made, and concluding that as long as coaches are cleansed and aired, the danger is of slight consequence. 4800 w. Pro St Louis Ry Club—Feb. 9, 1906. No. 75309.

Cars.

All-Steel Drop Bottom General Service Gondola Car for the Frisco System. Illustrated description of cars showing new points in design. 800 w. R R Gaz Vol. XL., No. 12. No. 75644.

Box Car for Automobiles. Illustrated description of a type of car being built at the Pennsylvania's shops for the transportation of automobiles. 600 w. Ry & Loc Engng—March, 1906. No. 75488 C.

Electric Locomotives

Electric Locomotives for the Simplon Tunnel (Locomotives Electriques pour le Tunnel du Simplon). S. Herzog. A general description of the Brown, Boveri three-phrase locomotives designed for the Simplon-tunnel service. 2000 w. 1 plate. Génie Civil—March 10, 1906. No. 75717 D.

Tests on Electric Railway Traction (Essais de Traction Electrique). P. Dumas. A report of tests with electric locomotives on the narrow gauge railroad of Saint-Georges-de-Commiers at La Mure, in the south of France. The electric current is derived from the works at Grenoble. 30,000 w. Ann des Ponts et Chausseés—4 Trimestre, 1905. No. 75778 E+F.

The Single Phase Electric Locomotive for Heavy Passenger and Freight Service. C. Renshaw. On the Development of the single-phase alternating current motor and its practical application for the electrical operation of trunk line service. Interesting discussion. Ills. 7000 w. Pro Ry Club of Pittsburgh—Dec. 22, 1905. No. 75626 C.

Fire Boxes.

Recent Investigations of Copper Fire Boxes (Neue Versuche mit Kupfernen Feuerbuchen). G. Dinglinger. A study of the behaviour of copper in the fire boxes of locomotive boilers as regards expansion, safety and efficiency. 2000 w. Glasers Annalen—March 15, 1906. No. 75751 D.

Inspection Cars.

Motor-Driven Inspection Cars for Railway Service. Illustrates one of the Sheffield Car Co.'s gasoline motor cars, and Olds single-cylinder railway motor car, with descriptive notes and general discussion. 1200 w. Eng News—March 8, 1906. No. 75439.

Locomotive Frames.

The Repairing of Locomotive Frames. From a paper read by S. Uren before the National Railroad Blacksmiths' Association. Illustrates and describes methods of welding. 1300 w. Am Engr & R R Jour—March, 1906. No. 75315 C.

Locomotives.

Compound Express Locomotive, Midland Railway. Two-page engraving showing a longitudinal section and sectional plan of the engine, with particulars of interest. 600 w. Engr, Lond—March 9, 1906. No. 75606 A.

Fast Passenger Locomotive for Heavy Service; Chicago, Milwaukee & St. Paul Ry. Illustration, with description of a design for a six-coupled engine of the Pacific type (4-6-2). A comparison with three other large engines is given. 1500 w. Eng News—March 15, 1906. No. 75521.

Heavy American Type Locomotive for the Central Railroad of New Jersey. Illustrated description of an 8-wheel passenger locomotive with Walschaert-valve motion. 500 w. Ry Age—March 16, 1906. No. 75576 .

Large Electric and Steam Locomotives. J. E. Muhlfeld. Gives a comparison of the performance of electric and steam locomotives in actual service, and discusses the requirements and results, and all matters of related interest. An important paper, with an interesting discussion. 17500 w. Pro N Y R R Club —Feb. 16, 1906. No. 75536.

New Locomotives, London, Brighton and South Coast Railway. Charles Rous-Marten. Illustration with remarks on the novel features, giving principal dimensions. 2000 w. Engr, Lond —Feb. 23, 1906. No. 75375 A.

Six-Coupled Tank Locomotive: Furness Railway. Illustrated description of a powerful 6-wheels coupled radial-tank engine, to be used for hauling heavy trains. 500 w. Mech Engr—March 17, 1906. No. 75699 A.

Locomotive Tests.

Comparisons Between the Efficiencies of an American and an Austrian locomotive (Vergleich der Leistungs fähigkeit einer Amerikamschen mit einer Oesterreichischen Lokomotive). R. Sanzin. The data for the American engine are taken from the P. R. R. tests at St. Louis; the Austrian data are from road trials on the Arlberg division of the Austrian State Railways. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 16, 1906. No. 75731 D.

Oscillations.

The Oscillations of Railway Vehicles on Entering and Leaving Curves (Les Oscillations du Materiel des Chemins de Fer à l'Entrée en Courbe et à la Sortie). Georges Marié. An exhaustive mathematical and practical study of the action of centrifugal and inertia forces to produce oscillations. 10000 w. Mem Soc Ing Civ de France—Nov., 1905. No. 75728 G.

Stability.

Stability of Trains on a Track of O-60 Metre Gauge (La Stabilité des Trains; La Voie de Om. 60). Col Péchot. Discussing especially the availability of track of about 24-inch gauge for military purposes, including details of construction and operation. 25,000 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1905. No. 75771 E & F.

Stoker.

The Hayden Mechanical Stoker. Illustrated description of a stoker for use on the large locomotives of the present, its operation and test. 4500 w. R R Gaz—Vol. XL., No. 9. No. 75317.

Trucks.

The Radial Truck. Prof. C. A. Carus-Wilson. Lecture delivered before the Tram & Lgt. Rys, Assn. An illustrated article discussing points of interest connected with the working of the radial truck, and attempts made towards its more perfect development. 2500 w. Engng—March 16, 1906. No. 75808 A.

NEW PROJECTS.

Extension.

The Western Maryland Extension from Cherry Run to Cumberland. Ralph C. Davison. Illustrated description of an extension of 59.3 miles through a rough country. 5000 w. R R Gaz—Vol. XL., No. 11. No. 75545.

Improvements.

The Chicago & Eastern Illinois 1905 Improvements. Illustrates and describes extensive improvements made necessary by the heavy coal traffic, on the Chicago division of this line. 3000 w. R R Gaz—Vol. XL., No. 11. No. 75547.

India.

Railway Construction in India. Gives views and brief notes concerning the work. 500 w. Engr, Lond—March 16, 1906. No. 76802 A.

New Line.

The Western Pacific. An account of this new line being built from San Francisco to Salt Lake City to serve as a Pacific connection for the Gould system of railroads. Map. 1200 w. R R Gaz—Vol. XL., No. 11. No. 75546.

Projected Railways.

Projected International Railways. A report of the projected trans-Alpine routes, with maps and information relating to them. 3800 w. Engr, Lond——March 9, 1906. Serial. 1st part. No. 75605 A.

PERMANENT WAY AND BUILDINGS.

Ash Handling.

Ash Handling Plants at Railway Ash Pits. Illustrates and describes the plant at McKees Rocks, Pa., near Pittsburg; and the Robertson ash-handling system at West Milwaukee, Wis. 1200 w. Eng News—March 22, 1906. No. 75650.

Ballast.

Ballasting. Abstract of report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with discussion. 7300 w. Ry Age—March 23,, 1906. No. 75819.

Freight-Yards.

The Design of Yards for Classifying Freight Cars. W. A. MacCart. Considers some of the plans and methods of yard operation now in use and the efforts being made to develop some method to minimize the delay to freight traffic. 6500 w. Eng News—March 15, 1906. No. 75523.

Frogs.

Frogs Without Guard Rails. Illustrates and describes the Conley frog, which has as its especial feature the outer raised guard rails, bolted to the frog rails. Also the Graham frog, which has flange blocks or guards of Menard hardened steel bolted to the frog rails. 1000 w. Eng News—March 15, 1906. No. 75524.

Grades.

Grade Separation at Cleveland, Ohio. George H. Tinker. An illustrated description of work in progress and completed. 1500 w. R R Gaz—Vol. XL., No. 12. No. 75643.

Improvements.

Wabash Improvements East. Map and illustrated description of recent and current development and betterment of the Pittsburg Terminal and the Wheeling & Lake Erie lines. 3000 w. Ry Age —March 23, 1906. No. 75812.

Rail Joints.

See Street and Electric Railways.

Rails.

Specifications for Steel Rails. Gives the specifications and recommendations adopted by the Am. Ry. Engng. and Main. of Way Assn., the Am. Soc for Test. Materials, and the Am. Soc. of Civ. Engrs. 2500 w. R R Gaz—Vol. XL., No. 11. No. 75551.

Reinforced Concrete.

The Use of Armoured Concrete in Railway Work in Russia. Serge de Kareischa. The first part contains particulars of the investigations made in Russia on the question of armoured concrete; and the second part describes in greater detail the methods adopted in the case of various constructive works. 13000 w. 17 tables. Ills. Bull Int Ry Cong—Feb., 1906. No. 75415 E.

Shops.

In the Railroad Shops. A. S. Atkinson. Calls attention to improvements recently observed in methods of arrangement, lighting, setting of machines, &c. 2300 w. Am Engr & R R Jour—March, 1906. No. 75314 C.

Ivorydole Shops, Cincinnati, Hamilton & Dayton Ry. Illustrated detailed description of terminal plant and repair shops. 3300 w. Ry & Engng Rev—March 3, 1906. No. 75347.

Some Small Successful Shop Savings. C. J. Crowley. A short paper on this subject, introducing a lengthy general discussion. 11000 w. Pro W Ry Club—Feb. 20, 1906. No. 75619 C.

The Electrical Equipment of the South Louisville Shops of the Lolisville & Nashville. Illustrates and describes interesting applications of the electric drive. 1000 w. R R Gaz—Vol. XL., No. 10. No. 75442.

The Missouri Pacific Shops at Sedalia, Mo. Illustrated detailed description of new shops. 4500 w. Ry Mas Mech—March, 1906. No. 75346.

Signals.

Signaling and Interlocking. Abstract of a report presented at meeting of the Amer. Ry. Engng. & Main. of Way Assn., with discussion. 9500 w. Ry Age —March 23, 1906. No. 75822.

Stations.

Santa Fe Standard Concrete Depots. Illustrates and describes some of these buildings, 21 of which are under contract. 1000 w. Ry Age—March 23, 1906. No. 75816.

The Washington Terminal Station. Theodore Starrett. An illustrated description of the concrete foundation work which has recently been completed on the new railroad building now in course of construction. 800 w. Cement Age—March, 1906. No. 75465.

Subways.

Reinforced-Concrete Subways on the Chicago, Burlington & Quincy Ry. Describes subways being constructed at Galesburg, Ill., in connection with a large classification yard. Ills. 2200 w. Eng Rec—March 10, 1906. No. 75478.

Switches.

A New French Pneumatic Interlocking Machine. Illustrated detailed description of a new design of machine being installed at numerous stations in France for interlocking switches and signals. 6000 w. Ry & Engng Rev—March 17, 1906. No. 75587.

Interlocking on the Lackawanna at Roseville. Illustrated description of a recently completed plant of 49 levers, at Newark, N. J., having special details of interest. 1200 w. R R Gaz—Vol. XL., No. 13. No. 75837.

Substituting Track Circuits for Detector Bars. W. N. Spangler. Read before the Ry. Sig. Assn. Calls attention to the features to be guarded against in electric lock signals, and the need of testing and inspection each day; urges the advantages of the track circuit over the detector bars. 2300 w. Ry & Engng Rev —March 24, 1906. No. 75677.

Switching.

Gravity Switching in Railway Yards. Explains the operation of the gravity system, referring to the Edge Hill yard, near Liverpool, England. 2500 w. Eng News—March 22, 1906. No. 75653.

Summit or Hump Yards for Gravity Switching. Abstract of the report of the Committee on Yards and Terminals, presented at meeting of the American Railway Engng. & Main. of Way Assn. 1200 w. Eng News—March 22, 1906. No. 75654.

Terminals.

East Altoona Engine Terminal of the Pennsylvania. Rodney Hitt. Illustrated description of a new terminal which handles more engines a day, probably, than any other engine terminal in the United States. 4500 w. R R Gaz—Vol. XL., No. 11. No. 75548.

The Atlantic Avenue Terminal of the Long Island Railroad. Illustrated description of this new terminal built in connection with the extensive improvements and electrification of this line. 3500 w. Eng Rec—March 3, 1906. No. 75402.

Yards and Terminals. Abstract of a report presented at meeting of the Am. Ry. Engng. & Main. of Way Assn., with discussion. 3800 w. Ry Age—March 23, 1906. No. 75820.

Third Track.

Lackawanna Third-Track Work at Scranton, Pennsylvania. Hugh Rankin. Explains the causes of congestion at Scranton, and the new third track to relieve the conditions. Many illustrations of interesting work. 2000 w. R R Gaz —Vol. XL., No. 11. No. 75549.

Ties.

Steel Cross Ties. W. F. Miller. Presents illustrations of types that have attracted attention, giving descriptions and other information. Discussion. 5000 w. Pro Engrs' Soc of W. Penn—March, 1906. No. 75620 D.

Ties. Abstract of report presented at meeting of the Am. Ry. Engng & Main. of Way Assn., with discussion. 15800 w. Ry Age—March 23, 1906. No. 75818.

Ties—The Supply and Demand. Gives an outline of the sources of supply and an estimate of the number of ties required annually, with an account of efforts being made to provide for the future supply. 2500 w. R R Gaz—Vol. XL., No. 11. No. 75544.

Track.

Five Years of Heavy Track Construction (Fünf Jahre Starkstoss Oberbau). A. Haarmann. An account of the behaviour of a section of railway between Hasbergen and Osnabrück, comparing the behaviour of steel and wooden cross-ties. 5000 w. Glasers Aunalen—March 1, 1906. No. 75722 D.

Track Elevation.

Chicago & Western Indiana Track Elevation at Chicago. Illustrations and descriptive notes on the work done in 1905. Earlier work having been previously described. 1000 w. Ry Age—March 23, 1906. No. 75815.

Washout.

Colorado River Crevasse—Salton Sea—Southern Pacific Tracks. Official statement of the causes and results of the misfortunes in the irrigation project of Southern California. I. The Causes of the Flood and Results of Efforts to Stop It. C. R. Rockwood. II. How the Flood Affected the Southern Pacific Railway. C. H. Ellison. 5000 w. Ry Age—March 23, 1906. No. 75813.

TRAFFIC.

Rates.

Rate Making on the Trunk Lines. Abstract of an article by Prof. William Z. Ripley, in the Feb. issue of the *Quarterly Journal of Economics*. 2800 w. Ry. Age March 2, 1906. No. 75348.

Senator Foraker's Speech. Extracts from speech before the U. S. Senate in opposition to the Hepburn Bill. Considers it unworkable and unconstitutional. 6800 w. R R Gaz—Vol. XL., No. 10. No. 75443.

The Reform of Passenger Rates in Germany. Translated from *Zeitung des Vereins*. 4000 w. Bul Int Ry Cong—Feb. 1906. No. 75416 E.

Report.

Pennsylvania Railroad. Editorial review of the report of the last year and its evidence of remarkable prosperity. 4300 w. R R Gaz—Vol. XL., No. 10. No. 75440.

MISCELLANY.

American Railways.

The German Report on North American Railways. Balthasar H. Meyer. A review of the report of the engineers who visited the United States at the time of the Louisiana Purchase Exposition. The remarks are mostly confined to the comparisons and opinions brought out. 3500 w. Ry Age—March 9, 1906. No. 75472.

Avalanches.

Experiences with Landslide Protection in Austria (Ueber Erfahrungen im Lawinenverbau in Oesterreich). Vincenz Pollack. Data concerning the effectiveness of protection works in the Austrian Alps against avalanches, snow slides, and wind in various grades. Serial. Part I. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 9, 1906. No. 75735 D.

Fighting the Avalanche. Describes the action of avalanches as seen on the Canadian Pacific Railway, and the defense works for keeping railway lines open, and of overcoming blockades. Ills. 1600 w. Ry & Loc Engng—March, 1906. No. 75486 C.

China.

The Railways of China (Les Chemins de Fer de Chine). A general account of recent railway work in China, with map of existing and projected lines. 2500 w. Génie Civil—Feb. 24, 1906. No. 75716 D.

Hindustan.

The Railways of Hindustan. (Die Eisenbahnen Vorderindiens). Dr. Blum & E. Giese. Describing especially the stations, terminal connections and operative methods of the principal railways of the peninsula; with map. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 24, 1906. No. 75700 each D.

STREET AND ELECTRIC RAILWAYS

Birmingham, Ala.

Recent Improvements in Birmingham, Ala. The present article gives an outline of the operations and properties of the Birmingham Railway, Light & Power Company. Ills. 2000 w. St Ry Jour—March 24, 1906. No. 75678 C.

Cable Traction.

The Electric Cable Road at Nancy (Le Funiculaire Electrique de Nancy). G.

E. Bernardet. Illustrating an inclined cable railway to the summit of a hill 229 metres high, near Nancy, France. The cable runs continuously, and the number of cars is varied to suit the traffic. 2000 w. 1 plate. Génie Civil—March 3, 1906. No. 75725 D.

Costs.

Cost of Electric Railway Power Production and Transmission in the State of Indiana. Albert S. Richey. Considers the average costs per unit of power on the Indiana interurban roads. 2500 w. Jour Worcester Poly Inst—March, 1906. No. 75614 C.

Electric Locomotives.

See Railway Engineering, Motive Power and Equipment.

Elevated Railroad.

See Civil Engineering, Construction.

Interurban.

Operating Features of the Dayton & Troy Railway. An illustrated description of methods adopted on a successful short line in Ohio. 4400 w. St. Ry Jour —March 10, 1906. No. 75481.

London.

Baker Street and Waterloo Railway. Illustrated detailed description of this recently completed tube railway, its equipment, rolling stock, traffic, prospects, finances, &c. 11000 w. Tram & Ry Wld —March 8, 1906. No. 75634 B.

The London County Council Tramway Power Station at Greenwich. Illustrated detailed description of this large modern generating station in course of erection. 2300 w. Engng—March 2, 1906. Serial. 1st part. No. 75508 A.

Manila.

The Manila Electric Railway. An illustrated article describing the modern public lighting and transportation system installed, and giving information of interest in regard to its construction and the native labor employed. 3000 w. Ry & Engng Rev—March 17, 1906. No. 75586.

Monorail.

The Behr Monorail System. Charles Edmund Tingley. Illustrated description of this system, which is under consideration for a line from the Interborough terminus at Flatbush and Atlantic avenues, Brooklyn, to Coney Island. 1600 w. Elec N Y—March 7, 1906. No. 75380.

Municipal Ownership.

See Industrial Economy.

Operation.

Electric Railway Engineering. William Cooper. Discusses the control of cars and trains operated by direct current. 3800 w. Elec Jour—March, 1906. No. 75627.

Puget Sound.

The Puget Sound Electric .Railway An illustrated description of its physical features, equipment, passenger and freight traffic, operating system and accounting. 4500 w. St Ry Rev—March 15, 1906. No. 75639 C.

Single-Phase.

Single-Phase Electric Equipment for the New York Terminal Division of the New York, New Haven & Hartford R. R. Brief illustrated description of the 11,000-volt single-phase electric locomotive for this road. 3000 w. Eng News —March 22, 1906. No. 75655.

Sleet.

Fighting Sleet on the L. & W. V. R. R. Brief illustrated account of the sleet-fighting equipment as an example of the methods considered best for the third-rail electric road between Scranton and Wilkesbarre, Pa. 1000 w. Ry & Engng Rev—March 10, 1906. No. 75474.

Stray Currents.

See Civil Engineering, Water Supply.

Substations.

Transforming and Distributing Substation at Montreal, Canada. J. A. Burnett. Illustrated detailed description of the Mentana Street substation and the general scheme of connecting up the apparatus in the station. 2200 w. Elec Rev, N Y—March 17, 1906. No. 75561.

Subway.

Building the Brooklyn Subway. George L Fowler. Describes the subway system that is being constructed to connect the Long Is. R. R. with the East River tunnels and the subway system of New York, explaining methods of execution, and some of the difficulties. Ills. 3300 w. R R Gaz—Vol. XL., No. 11. No. 75550.

Sweden.

Electric Traction on Swedish Railways. Reviews a recently published report on the question of utilizing the unused water power of Sweden for generating electric power for the railways. 800 w . Engng—March 9, 1906. No. 75598 A.

Train Dispatching.

Train Dispatching on the Rochester & Eastern Rapid Ry. W. R. W. Griffin. Describes the method adopted by this electric railway in New York State. 3000 w. St Ry Rev—March 15, 1906. No. 75640 C.

Welding Rail-Joints.

A New System of Electrically Welding Rail-Joints. Brief illustrated description of a method being employed in Germany. A high temperature is secured by the use of a large electric arc. 700 w. March 17, 1906. No. 75577 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves readv to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York

Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford. U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Instituts Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

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FIRE LOSSES IN THE UNITED STATES. A GRAVE NATIONAL QUESTION.

By Joseph K. Freitag

The importance of Mr. Freitag's topic needs no emphasis save that which is afforded by the San Francisco disaster, still fresh in the public mind. And yet the totals of the loss of life and property there, frightful as they seem when condensed into a single event, Mr. Freitag shows to be *less than the regular, annual aggregate of similar losses in the United States.*

If San Francisco teaches a sterner lesson of the peril and waste of non-fireproof construction than ever was presented before, she has now the opportunity of more complete and thoroughgoing reformation in building methods than was ever offered to any American city. Should she become—as we hope she may—an example of the new order, as well as a warning against the old, even so appalling a wreck as her fire ruins now seem may bring a train of economic blessings upon the country at large.—THE EDITORS.

THE great loss of life and property which has resulted from the devastation by earthquake and conflagration of the greater part of San Francisco, serves again to bring before the American people in a most emphatic manner a civic question than which few are of greater practical importance—namely, the apparent national indifference in the United States to the enormous annual drain upon the national resources occasioned by fire losses, which is largely the result of carelessness in building laws and methods.

In judging of the causes and effects of this disaster, we must distinguish between the inevitable workings of great natural forces on the one hand, and those controllable human agencies on the other hand which, with the proper foresight for communal interests, could have prevented the larger share at least of the great losses of human life and property involved. Thus while no human agency could have prevented the seismic disturbance which was undoubtedly responsible for much of the initial disaster, this is not equivalent to saying that much of the consequent wreckage of buildings, loss of life, and also the conflagration which so swiftly followed, could not and should not have been prevented.

It seems to be plain, judging from early accounts at least, that the principal damage from earthquake occurred to the cheaper, more poorly constructed, non-fire-resisting buildings—a class of buildings which, in any congested city area, should have been prohibited by building laws long before this, especially in a locality where earthquake disturbances were not unlooked for at any time.

Disregarding for the present the direct results of the earthquake shocks, except in so far as fire immediately resulted as a natural consequence, we are brought face to face with the ever-recurring fire hazard which obtains in all the large American cities—in fact, with the question of fire-resisting construction, or the lack of it, throughout the United States. Certainly past experiences have not been wanting to impress the great lesson of fire-waste upon the American people. Witness the great Chicago fire of 1871 in which 3⅓ square miles of buildings were destroyed, involving the loss of $190,000,000 and two hundred and fifty lives, and the wrecking of fifty-six insurance companies; the Boston fire of 1872, laying waste 65 acres with a loss of $80,000,000; the fire at Jacksonville, Fla., in 1901, with a loss of $10,000,000; the Paterson, N. J., fire of 1902, involving a loss of $8,000,000; the Baltimore conflagration of 1904, destroying 140 acres of buildings at a loss of over $50,000,000; and now the San Francisco calamity, said to approximate over $200,000,000 in property loss. Surely the list is sufficiently impressive to be taken to heart, but even these figures do not tell the whole story of our national fire waste in the United States. Many other conflagrations of lesser extent and fires in individual buildings have increased the total, year by year, until in 1904, insurance tabulations show that the total loss by fire in the United States was $230,000,000, or an average daily loss of $630,000.

In the seventies, the annual fire loss was approximately $60,000,000; in the eighties, about $100,000,000; while in the nineties the yearly figures averaged nearly $150,000,000. Or, to show even more plainly what this stupendous drain upon the resources of the country really means, take the actual losses by fire tabulated by the National Board of Fire Underwriters, and it will be found that, in the past twenty-five years, no less than $3,500,000,000 worth of property has been sacrificed to this national waste. This great total may be better appreciated if compared to this national debt of the United States, which, at the highest point ever reached, on July 1, 1866, amounted to $2,733,236,173.

It has been estimated that our annual fire loss now represents a tax of $25 per year per family of population. This loss is a total one, and it is only the great prosperity of the country and the vast national wealth which has permitted the carrying of this burden so long. If the national resources of the United States had been less, if the measure of prosperity had been less generously meted out to the country, it is inconceivable to presume that such a drain could or would be permitted with such indifference. But if the proposition were to be made to the people of the United States to increase their national indebtedness during the next twenty-five years by $4.000,000,000 or $5,000,000,000,—the fire waste which may be expected within that period from present indications—what consternation and dismay would immediately result, even though a large part of the expenditure were proposed for distinct public improvements!

To all figures of fire loss heretofore mentioned must still be added the enormous expense of maintaining fire departments, extra water supplies, and all appliances and equipment now furnished and supported for the purpose of assuaging the results, but not curing the evil. Such total annual expenses are probably not less than $150,000,000, a sum which, in itself, would go far to cure the deeper and truer cause of its being.

It is true that the modern institution of fire insurance serves so to distribute the enormous fire losses over the entire community and country that the burden of any particularly great calamity is not directly felt by the people as a whole. This is one great reason, doubtless, for the apathy displayed in regard to lessening the evil of fire waste; for if each individual realized his fractional share of the loss, the fact would be more readily appreciated that he, and not the insurance company, must ultimately "pay the piper."

There is another side, however, to the fire problem which unfortunately forces the personal relation with the individual. This is the loss of life occasioned by fire horrors, of which the burning of the Iroquois Theatre furnishes one of the more terrible examples. Thus in 1904, nearly 7,000 people lost their lives in fire casualties in the United States, a daily average of nineteen lives throughout the year, thus nearly equalling the deaths from railroad disasters in the country, where the statistics for such casualties show confessedly the worst conditions in the world.

The remedy for these great losses of life and property is not to be found in either increased insurance, or improved methods of fighting fire. Insurance is a palliative and not a cure, and the same may be said of fire departments. Neither reaches deep enough to effect the removal of the cause, and make impossible fires of any degree of magnitude. Of course, fire-fighting facilities will always be required to cope with incipient fires, but the true underlying remedy for this great loss of life and property must lie in the *universal application* of fire-resisting methods to building construction—not in mercantile buildings in congested city areas alone, but in all schools, churches, places of amusement, hospitals, town-halls, and even in city and country residences.

For, the efficiency of fire-resisting construction varies with the *universality* of its adoption. No building can be considered as a unit, regardless of its neighbors, for as long as a modern fireproof (or fire-resisting as it is now generally called by fire protectionists) building stands in the midst of highly dangerous inflammable neighbors, just so long is the term fireproof a misnomer, and highly misleading to the layman who thinks that, because termed "fireproof," the structure is therefore proof against all fire damage to itself or to its contents. This was well exemplified in the Baltimore fire, where the structures which had been built after fire-resisting methods were found to have been gutted by fire, and to have sustained great damage, although still standing and capable of being re-used, at least as far as the essential structural portions were concerned. But it must be remembered that no building erected of the materials which Nature has given us to use can be designed or constructed to withstand conflagration at its height.

Fireproof buildings must stand in fireproof cities, for each added example of fire-resisting construction contributes just so much to the bulwarks protecting all. We know by ample experience that buildings can be and are being constructed which will safely withstand all that can reasonably be expected of them as to fire-resistance—namely, that under any ordinary conditions they will safely confine fire within the edifice or compartment where it originated, or safely exclude fire from any exterior hazard of not too great intensity. Their ability to fulfil these conditions has been fully demonstrated, both by buildings threatened by destruction from without where the construction has prevailed against the attack, and in other cases where the fire-resistance of the structure served to confine an otherwise dangerous fire to the compartment where it originated, almost without the knowledge of other occupants of the building. But individual examples are not sufficient. The practice of fire-resistance must be so universal in building construction that no conditions could result in the spread of fire beyond the original premises, or at least beyond immediate neighbors. Both the Paterson and Baltimore fires plainly demonstrated the ability of adequate fire-resisting structures to obstruct even conflagration in its path.

It is both interesting and instructive to compare fire losses in American cities with cities of England and Europe where fire-resistance has been plainly recognized as a public necessity for centuries past.

In New York, Boston, Philadelphia, the annual number of fires has been steadily increasing, and in far greater proportion than the growth of population. The same conditions hold true in London, Berlin, and Paris; but whereas the total American losses have increased out of all proportion to city growth or expansion, fire losses in Continental cities have not materially increased. The annual fire loss in Boston is now about $1,500,000, while in an average European city of equal population the fire loss will be found seldom to range over $150,000. And this is in spite of the fact that the daily number of fires will be about the same, and in spite of the usually marked superiority of American fire-fighting facilities. The real reason for the difference is to be found in the methods of building construction. While American cities have permitted the erection of "fire-traps" on every hand, Continental municipal regulations limit the height and area of buildings, the character of the building materials, and generally enforce adequate fire-resistive construction throughout all city buildings.

By referring to the Special Consular Reports made in 1892 to the State Department of the United States giving fire and building regulations in foreign countries, it will be found that in such cities as Havre, Rouen, Milan, Rome, Brussels, Antwerp, and Leeds, Sheffield and Bristol in England, every fire in the year 1890 was confined to the building in which it originated; while in Dresden, Florence, Vienna and other cities, every fire was confined to the *floor* on which it originated.

In Hamburg, out of a total of 682 fires in 1890, 659 were confined to the floor where they started, 669 to the building, while only 10 fires extended to the adjoining property. A conflagration, or the extension of fire beyond the immediately adjoining property, had not been known since 1842. And we must bear in mind that many of these results are obtained in spite of what Americans would consider the most ridiculous fire-fighting facilities. Thus in Rome, where, in 1890, 328 fires were practically all confined to the *room* of the origin, the following description of the extinguishment of fires was given by Consul-General Bourn:—

"Buckets and fire extinguishers are chiefly used for extinguishing fires. If these are not sufficient, small hose, perhaps of 1¼ inches in diameter, are brought into service. But the force of water in many parts of the city is not great, although the supply is very abundant. If the hydrant pressure is not sufficient, small portable fire engines are used, and in cases of great emergency there is one steamer; but as it is so seldom required, no proper arrangements exist for bringing it into service. The last time the steamer was called out it was over two hours before it was ready to throw water on the fire."

Or, again, take the fire record of 1890 in the Spanish city of Malaga, amounting to but $5,000, with a population of 135,000 persons. The entire fire department was most primitive, about equal to what would be found in a small American town say fifty years ago, yet the prevalent mode of building of brick, stone, and iron, with heavy fire-walls between all buildings, has accomplished this most insignificant fire loss.

Naturally, the scarcity of lumber for building purposes, and its consequent high price, has had much to do to bring about this status of building methods; while in the United States lumber has been available, cheap, and most readily adaptable to building uses. But fortunately, in this respect at least, lumber has been steadily advancing in price until some grades have increased as much as 150 per cent during the past few years, while steel, brick, stone, cement, and the clay products have been gradually decreasing in price, until there are good commercial as well as civic reasons to hope that the hitherto Utopian accomplishment of universal fire-resisting construction may soon replace the era of jig-saw and wood-frame. Independent of the added element of security against fire, fire-resisting construction of proper materials will be found to be cheaper in the long run, decreasing repairs and insurance premiums, giving immunity from vermin, reducing the transmission of sound, and proving warmer in winter and cooler in summer than the older non-fireproof methods. At present prices, adequate fire-resisting construction may be estimated about 10 per cent dearer than ordinary methods of building; but as the deterioration of a well-built example of the former type has been estimated to be but one-tenth of 1 per cent a year, while that of an ordinary wood-joist structure is nearly 4 per cent a year, this initial difference is soon overcome.

It may be objected that the previous argument in favor of fire-resisting construction is all very well on general principles, but that it has no direct bearing upon the catastrophe at San Francisco, because, in this instance, the loss was largely the direct result of earthquake. Even from the earliest accounts of the San Francisco fire, this view may rightly be disputed, for reports so far received from the stricken city tend to show that comparatively little damage was done to the modern fire-resisting buildings by the seismic upheaval. The principal earthquake damage undoubtedly resulted to the flimsy, non-fireproof buildings, which, in falling to destruction, started conflagration on every hand, through which the better buildings were made to suffer.

San Francisco has long been known as a particularly hazardous fire risk, and insurance officials have even gone so far as to say that it was only the excellence of her fire department that prevented a conflagration long since. To quote from a description of San Francisco written in 1905: "In San Francisco, for instance, there is little being done to improve the standard of construction. It is notoriously a wooden city, yet insurance rates are fairly low, because, forsooth, the fire department is so excellent. That is like extolling the advantages of a certain locality as a health resort. It may be miasmatic; yellow fever may stalk amuck; its houses and streets may be foul, but, glory be, its doctors are skilful!"

Had the construction been uniformly fire-resisting, what a different result might have followed. For it so happens that our present methods of fireproof building are, undoubtedly, the most effective possible against earthquake disturbances. Our city buildings, at least, unless they are public monumental buildings, are seldom constructed, when made fire-resisting, of solid masonry. On account of the great area occupied by the foundations and piers of the older, solid construction, on account of the added height permissible with steel construction, and also because of its rapidity of erection, nearly all fire-resisting buildings of any magnitude are now built of the "skeleton" or "cage" construction, so called because the vital steel skeleton or framework, consisting of columns, girders, and floor-beams, when riveted together partakes of the nature of a metallic bird-cage—strong, rigid, and proof against distortion. The introduction of these methods in Chicago was the direct outgrowth of the necessities in the larger American cities for centralization within limited business areas, thus requiring the extension of buildings into the air to secure added floor space. This need was also felt in San

Francisco, and as the last previous seismic disturbance of any severity in that city had occurred in 1868, the introduction of steel-skeleton buildings in Chicago and New York in the latter eighties, immediately raised the question as to whether such construction could be made safely to withstand any earthquakes to which the locality of California might be subjected. The question was much discussed by architects, builders, and structural engineers, until, in 1890, the skeleton-construction Mills building was erected in San Francisco by Mr. D. O. Mills, as an evidence of his, or his architects', faith in the efficacy of this type of building. This faith was founded on the knowledge that steel frameworks of this character can be so designed as practically to permit of bodily overturning before failing in any portion. Indeed, in very high narrow buildings, exposed to severe wind pressure, it is no uncommon thing to anchor down the windward columns against possible overturning. Hence in localities subject to earthquake, the only serious danger would be in the construction or safety of the exterior masonry walls, and this is accomplished by tying in the brick or stone-work by metallic anchors attached to the steel frame. The Mills Building was soon followed by other similar structures, until, in 1897, the nineteen-story Spreckels Building was erected, 300 feet high; and it is to be hoped and expected that later accurate accounts will show that these steel buildings were practically immune from earthquake damage, succumbing only to the widespread conflagration, caused by the demolition of inferior, non-fireproof structures.

The remedy, then, if we are ever to learn the lessons of repeated disaster, must lie first with the Legislatures of the various States, who must, sooner or later, pass general building requirements similar to those in force in European countries; and secondly with the people in the earnest co-operation necessary to the carrying out of such laws. Then will be saved to the nation these tremendous losses of life and property, insurance burdens, and the taxes necessary to maintain its too expensive fire-fighting equipments.

TRANSPORTATION IN THE PHILIPPINES.

By Lawrence E. Bennett.

An article by the same author in our preceding issue gave a general outline of the resources, needs, and special features of the Visayan group, so far as concerns the development of railways in that part of the Archipelago. The present paper brings the reader into closer touch with the country, following the personal observations and experiences of the author while on his reconnaissance surveys. Since the publication of the first installment a change has been made in Mr Bennett's relations to the railway enterprise now under advancement by the White syndicate in the Visayan Islands. On account of his wide acquaintance among native officials and with the local government system, he has been appointed special right-of-way officer and will devote his entire attention to this work for the present.—The Editors

IN a preceding article, I outlined the existing railway systems of the Philippines, and the important new projects now being actively pushed to completion, together with the harbor works which will enormously increase the business importance of the seaport terminals. It was while engaged on the harbor works in the port of Iloilo that notification arrived of my commission to go over the ground of the proposed railroads for the interests represented by J. G. White & Company and associates. I was, in short, to make a reconnaissance survey with a view to reporting on the field as affording opportunity for railroad development.

Considerable familiarity with Visayan natives and a more or less comprehensive knowledge of their linguistic peculiarities, led me to decide that foreign escort or companions would be superfluous to my party. So I started from Iloilo on horseback, and with only my native cook and guide, my credentials, and letters of introduction. Possessed of experience in dealing with the natives, and a little tact, one may journey into the interior of these islands with reasonable assurance of meeting a hospitable reception, and dependence may generally be placed upon the native officials for generous co-operation in one's enterprise. Knowing the state of affairs, I had no hesitancy in traveling alone.

So much for the matter of personal safety. On my travels in these islands I was nevertheless destined to meet with surprises in my

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RAILWAY TRAVEL ON THE MANILA & DAGUPAN ROAD.

intercourse with the natives. Accustomed to the projection of engineering enterprises in China, where such proceedings often meet with systematic opposition, if not with open hostility, it was a pleasant surprise to find a rural population of Asiatics welcoming with open arms the prospect of a railroad. True, their ideas on the subject were primitive, and their interest analogous to that of children expecting the presentation of a new toy, but the immediate motive was immaterial; and it will be found also in the operation of the roads that returns accrue from this impulse quite as largely as from more logical causes. There is, even in China, a patronage of the modern steam railroad in service which is little short of remarkable. On the Imperial Railway of North China, it is an ordinary occurrence to see whole train loads of coolies riding herded together in open freight cars, under a broiling sun, the most of them apparently merely out on an excursion, with no particular objective point; riding for the fun of it. It is expected that during the initial stage of building up the freight traffic on the new Philippine railroads a large percentage of the revenue will result from the third-class passenger traffic, as is the case on the Manila & Dagupan Railroad.

A TYPICAL LARGE PLANTATION IN THE PHILIPPINES.

Main building of the Kane-Goodman coffee plantation, Lepanto; elevation, 5,000 feet.

The first day's trip was from Iloilo to Passi, an important interior town on the proposed route in Panay. The highway along this portion is built up for a distance of thirty miles with an almost uninterrupted succession of villages, and the population would average four hundred per square mile on a strip of considerable width. The cultivated land is divided into small holdings, averaging perhaps two acres to a family, and sugar is the great staple product of the lowlands. Some of the lowland, however, is devoted to rice cultivation, while the uplands back of the main line of travel produce coffee, cocoa, hemp and other valuable vegetable fibres.

At the present time the common transportation medium is the most primitive known—the shoulders of man. The usual load for an individual is fifty pounds, and the expense of transportation to the

TRANSPORTATION IN THE MOUNTAINOUS DISTRICTS OF THE PHILIPPINES.

At the 6,000-foot level on the Bontoc-Cervantes trail.

market for the average producer is thirty-five dollars a ton during the dry season. During the rainy season, transportation there is none.

In the face of these handicaps, the small planter supports his family on the produce of two acres of land, cultivated by the most primitive and wasteful methods. It is difficult to measure the productive possibilities of this region, presuming treatment by modern practices and tools. One native told me that he was using an American disc plow and found it many times more effective than the home article—which, indeed, seems to do hardly more than scratch the surface of the ground. In the course of my journey it was discovered that this was no isolated case, for many of the more progressive farmers are taking up such innovations, and with invariable success.

At Passi, the termination of the first day's journey in Panay, I was treated to the first of a series of pleasant social intermissions which recurred occasionally throughout our expedition. Here we were welcomed heartily by the local *presidente*, when he learned my mission, and he insisted on our staying over Sunday with him. As an inducement he promised an especially attractive entertainment in the afternoon.

Nothing loth, I rested with this genial host in anticipation of the treat. This turned out to be the weekly cock fighting, of which the mayor was an ardent patron, keeping himself a large quota of game cocks. Upon my host's advice I backed his entry, a big red chanticleer, in the first bout, which proved fatal to the antagonist in less than ten seconds. In another bout, impelled by the desire to back the under dog, I spurned the advice of my mentor and selected an admittedly doubtful looking small white bird. My candidate was outclassed, as might

Courtesy of Wm. Dinwiddie, Esq.

A PRIMITIVE FILIPINO INDUSTRY.

The copper-smelting furnace is charged with fragments in small crucibles, over which charcoal is piled.

A GROUP OF NATIVES, AWAITING EMPLOYMENT BY AMERICAN FIRMS.

have been expected; but I learned the lesson of following the advice of the chief executive of a Filipino municipality at a municipal cock main.

Cock fighting is the standard amusement in the Philippines, and an engineer undertaking large works with native labor may often insure a satisfactory outcome by regularly instituting the sport on a generous scale. Next to cock fighting, a band of music is essential; and in later operations I have always endeavored to provide these binding influences. The return on such an investment is quite inestimable.

Across Panay, from east to west, forming a divide at its midsection, there stretches a range of low-lying hills, where the population is much less dense than toward the north and south coasts, and where there are wide stretches of uncultivated territory. This is apparently because of inaccessibility, for splendid opportunities are offered here for the growing of hemp, cocoanut and fruits, notably the pineapple, from the fibre of which so much of the fine Philippine *jusi,* or grass cloth, is woven. From this highland region, the land slopes right away in wide, fertile plains down to the north coast and to Bataan and Capiz, the latter of which towns is the proposed terminus of the

Panay railroad, where, with a little improvement, will be afforded excellent harbor facilities. A branch from Dao on the main line to Bataan, further west on the north coast, is contemplated. The conditions of population and agriculture which exist on the southern slope of the divide are practically duplicated on the northern. During the last twenty miles from Dao to Capiz, we were always within stone's throw of a habitation and passed through populous villages at frequent intervals. The population of Panay is one hundred and seventy per square mile, and nearly all of the six-thousand inhabitants of the island will be served by the railroad, both for passenger and freight purposes.

So far as grading and location are concerned, there will be no great difficulties imposed upon railroad construction in Panay, the country varying from a level formation, like that of the American Middle West, to moderately hilly. However, there will be some difficulty encountered in providing against washouts on the plains during the rainy season. The natural water courses are quite incapable of carrying off all the precipitation during this period, so extra culvert and bridge structures will be numerous. The bridge work in the total mileage will figure as high as three per cent on many sections of the road. It has been decided to use only concrete and steel in culverts and bridges, thus making the roadbed more stable and enduring than we are accustomed to see in pioneer construction work in the United States. This applies to the proposed roads in Negros and Cebu as well. Certainly the problem is quite different from that which confronted the pioneer builders generally in America. It is rather comparable to the state of affairs which confronted the first British and European builders. Potentially the traffic is right there now, to all intents and purposes, merely awaiting the carrier, so thoroughgoing initial construction is well advised.

It is estimated that $35,000 will be expended per mile of single-track road in Panay, and $30,000 per mile each in Negros and Cebu. The less figure in the latter case is accounted for by there being more certainly defined and more capacious natural waterways on the islands in question. In the matter of grading and location, however, they will present rather greater difficulties than Panay, having a smaller percentage of level country on the proposed routes.

The return from Capiz to Iloilo was made on a small coasting steamer, the General Blanco, and the trip was memorable. Every plank and stanchion in the little Blanco seemed to be ingrained with the evil effects of a long indulgence in the transportation of decom-

COASTAL AND RIVER SETTLEMENTS IN THE PHILIPPINES

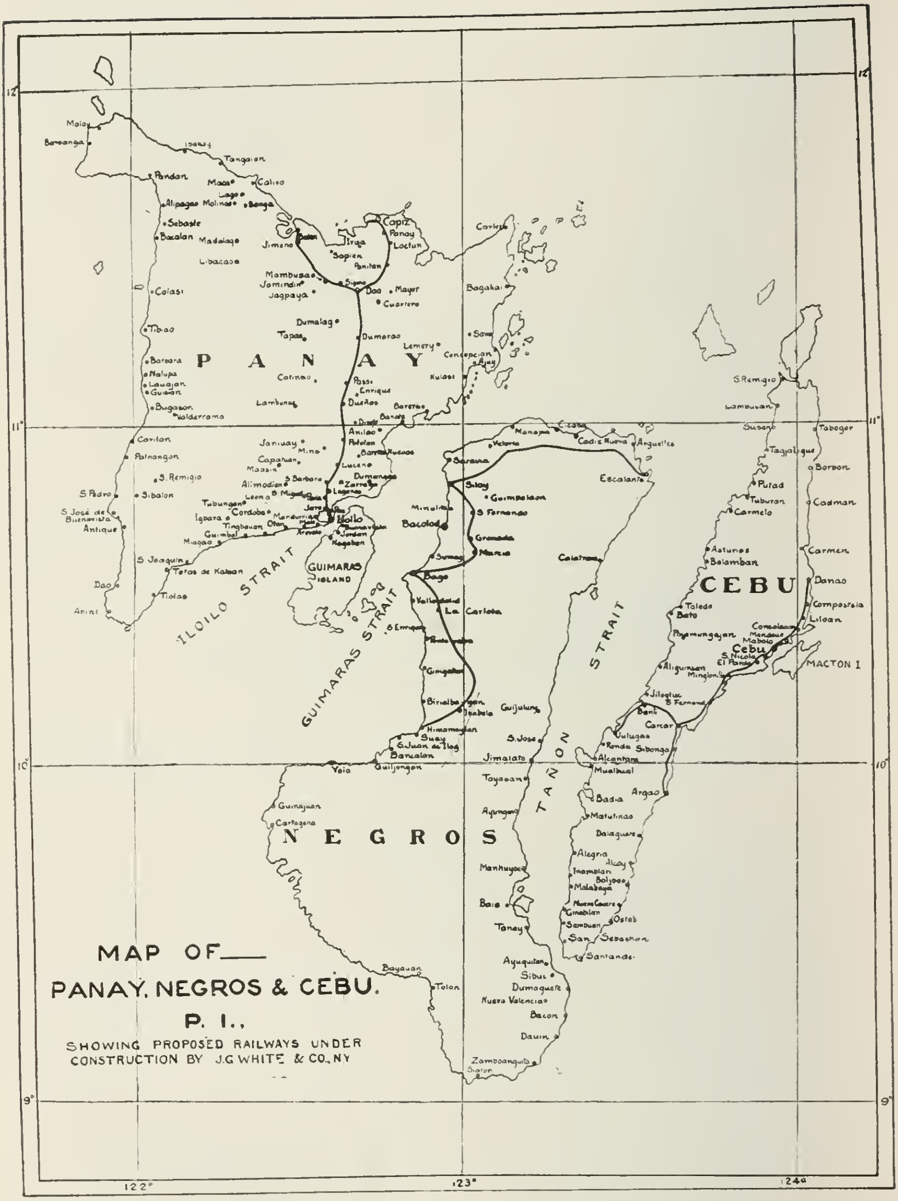
The upper view shows a river village above Iloilo; the lower is a portion of the coast of southern Negros.

posed fish. On this particular occasion she was loaded to the gunwales with the commodity, and the sufferings of the white element in the passenger list were acute during the two days' voyage. In all my experiences of travel, I have never met elsewhere with such a nauseous odor as emanated from that little craft. I would not even except a certain steamship loaded with garlic on which I once had the misfortune to travel from Alexandria to Brindisi. One lasting result of this voyage from Capiz to Iloilo was the necessary abandonment of a goodly percentage of my personal effects. In the Orient the flesh of fish is seemingly never too much decomposed for human consumption. On the Chinese railways there is a thriving traffic, from the coast inland, in fish of the skate variety. Frequently the period intervening between the catch and the actual consumption amounts to many days, under the effects of a semi-tropical climate. It is no cause for surprise, then, that the passage of a fish train generally demoralizes foreign settlements immediately along the route.

Courtesy of Wm. Dinwiddie, Esq.

NATIVE WATER TRANSPORT IN THE ARCHIPELAGO.

The next trip was devoted to an inspection of the railroad route on the island of Negros, which is separated from Panay by a narrow channel. Negros is the great sugar producer of the Philippines, and while its population is but 5 per cent of the total of the Archipelago, it produces half of the sugar grown. The output is now 80,000 tons annually, and adequate transportation will quadruple the figure, at a conservative estimate. The population is less than one-half that of



MAP OF THE ISLANDS OF PANAY, NEGROS, AND CEBU

Showing the railways projected and under construction. Scale about 21 miles to the inch.

Panay and the productiveness many times greater. Of hemp, too, this island is for its size one of the best producers in the Island possessions. It is probable, then, that whereas most of the revenue of the railroad in Panay will come from passenger traffic in the initial stages, the majority of the carrying trade in Negros will be freight.

The island of Cebu, with a population of 600,000, equal to that of Panay, and averaging 350 per square mile, produces sugar in some quantity, but the main staple is Indian corn, which was brought to the Philippines from America by early Spanish settlers. On certain parts of Cebu, it gives two and often three crops per year, each crop yielding two-hundred fold. It is among the few Philippine products demanding cultivation, so statistics are quite reliable. Cebu grows more corn than the best three of the other corn-producing provinces of the Archipelago combined. On this island, then, there will be a more even division of traffic return between the passenger and freight elements.

Negros and Cebu have, besides uncultivated resources, natural ones peculiar rather to themselves. Negros abounds in magnificent timber lands, while Cebu contains the most valuable coal deposits in the Philippine Islands. On Negros there are thousands upon thousands of acres bearing a variety of wood suitable for every feature of building. The coal resources of Cebu, even in the present primitive stage of development, have made coal-distributing centers of nearly all the important towns on the east coast of the island. The quality is about like that of the Japanese product, having approximately 80 per cent of the heating value of the best American soft coal.* The product of the mines of Sibuguey Bay has been tested on vessels of the United States Navy with very satisfactory results. It is altogether probable that, in the near future, Cebu will supply enough coal not only for the demand in the Islands, but for a large part of the merchant marine of the Pacific Ocean, a factor of prime importance in determining the course of commerce in the Orient.

The island of Negros is of volcanic formation and it is the volcanic ash in the soil which accounts for its superior sugar-raising qualities. As contrasted with the nature of land tenure in Panay, the cultivated area of Negros is held in large plantations, many having an area of two-thousand acres; still, the restriction of meagre, inefficient transportation facilities is quite as potent in one field as in the other, and Cebu is in precisely the same predicament.

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*The coal deposits of Batan Island were described at length in an illustrated article by O. H. Reinholt, in The Engineering Magazine for January, 1906.

TYPICAL ROUGH AND MOUNTAIN COUNTRY IN THE PHILIPPINES.

The upper view shows the Bued River gorge from the Zig-zag trail, Benguet Road. The lower illustrates a mountain stream, and shows the impossibility of marketing the abundant timber by ordinary modern logging methods.

The terminals of the Negros line will be Jimamailan, on the west coast, and Escalante, on the northeastern, both thriving trade centers. A range of mountains forms the backbone of the island, extending from near the northern end and culminating midway in the semi-active volcano Canlaon, located near the middle, northeast of Jimamailan. The railroad will skirt the western slope of this range and bend round the north end to Escalante.

We ascended the lower slopes of the volcano for prospecting purposes, and from the vantage point thus gained had a splendid view of the extensive forest tracts of interior Negros. The foot-hills and lower slopes are grown over with great, broad-leaved tropical trees, standing so close together that their branches interlock. From these trees come the fine Philippine hardwoods largely sought for interior work in building, and for engineering works where durability is the prime consideration. Generally these woods are extremely heavy. At many points there are broad areas of pure growth of the *lauan.* The quality of this species is peculiar. Very few varieties of tropical trees grow uninterspersed in this way. Moreover, for structural purposes the *lauan* is an excellent substitute for the white pine, possessing the essential physical attributes of that wood. The scope of the timber resources of Negros is thus seen to be quite comprehensive.

At present a very small quantity of this timber is marketed. Logs are snaked out, after falling, by means of carabaos and are then floated down to the coasts on various small streams. This is a long and tedious process because of innumerable snags and sand bars. Moreover, most of the hardwood must be kept afloat by means of bamboos. Undoubtedly, logging railways would be more economical for logging operations on a large scale than flotation, and it is probable that spurs will be built from the main trunk line in Negros for this special purpose. The report of the Philippine Forestry Commission on the resources of the Islands is not yet completed, but general figures already derived indicate that the standing timber aggregates one million million board feet, or more than double the amount in the States of Washington and Oregon combined. The stumpage alone of this timber is worth nearly three-billion dollars to the Government, quite aside from the indirect benefit which will be imparted to the country through development by private vested interests. Of this immense forest reserve, a considerable portion is in Negros—probably a greater quantity than is contained in any other province of the Philippines.

At the present time, nearly all of the structural timber used in the Islands and on the China coast is imported from the Pacific coast of the United States, at a freight rate which more than doubles the original cost of the cargo. Despite these prohibitive conditions, fortunes are being made in the import timber trade by foreigners in China. Herein again the imminent revolution of China—imminent in the light of National age—bears directly upon the welfare of the Philippines, for the single serious defect in China's array of potential wealth is the comparative lack of good building timber.

In Negros as in Panay a cordial reception was almost invariably accorded us by the local native officials, but at La Carlotta we met with a rather disconcerting rebuff. However, the circumstances were peculiar. We had been traveling all day in a drenching rain and arrived at La Carlotta after dark, very effectually masked with mud, both men and beasts. In this state we unthinkingly presented ourselves in the stygian darkness at the house of the *presidente,* wherein were many signs of a *fiesta* progressing. Upon our knocking, festivities ceased and the lighted windows were framed with the inquiring, half-alarmed faces of the inmates, who, observing a ruffianly looking

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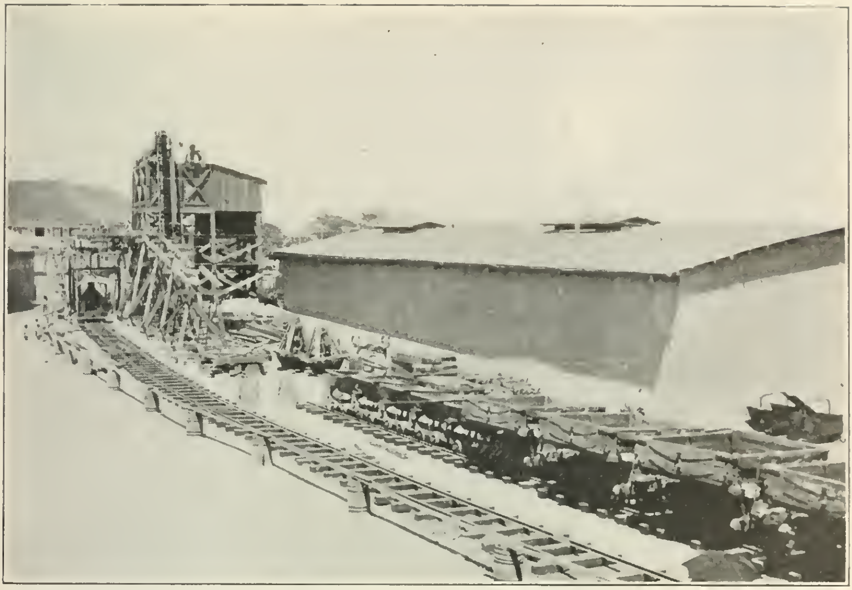
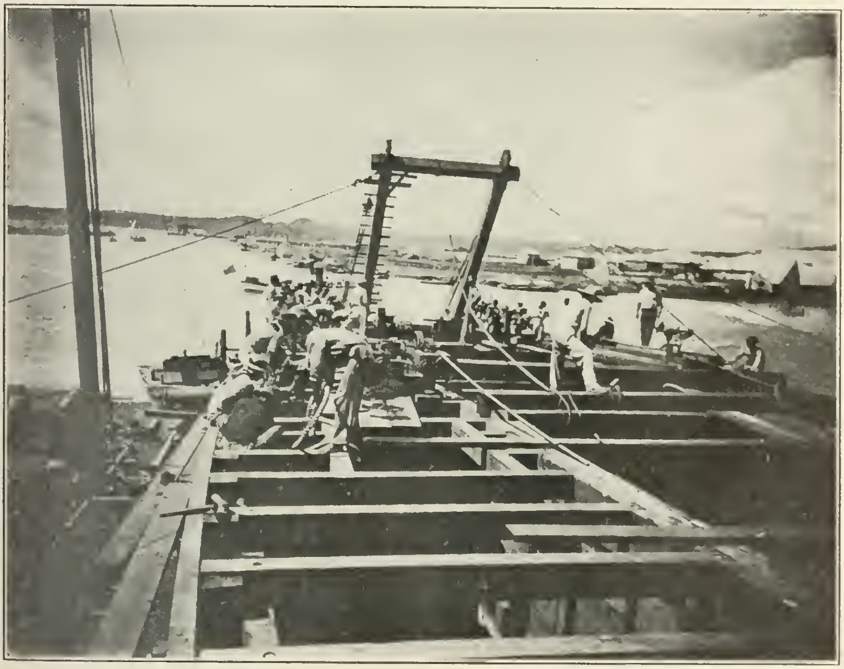
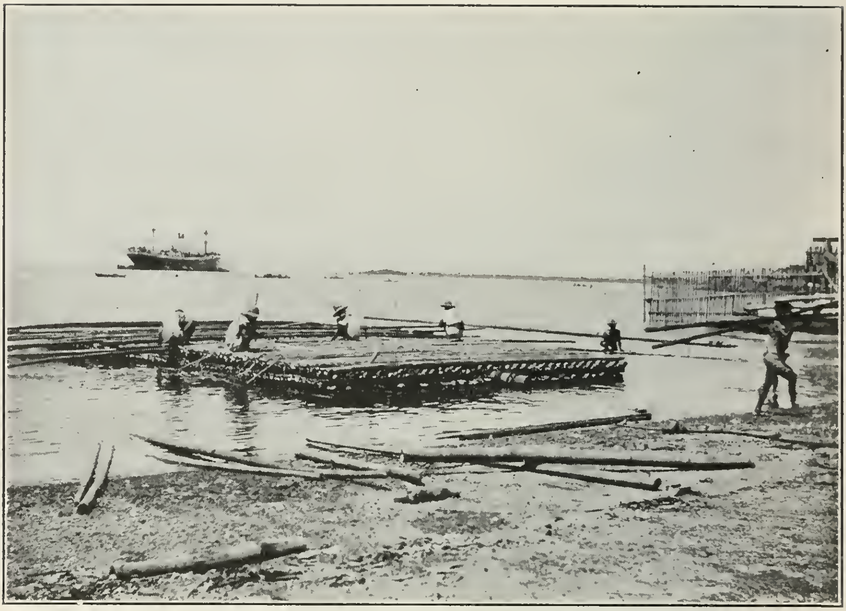
A FILIPINO SAW MILL, IN THE ISLAND OF CEBU.



THE BEGINNINGS OF THE NEW ERA. CONCRETE-MIXING PLANT, CEBU.

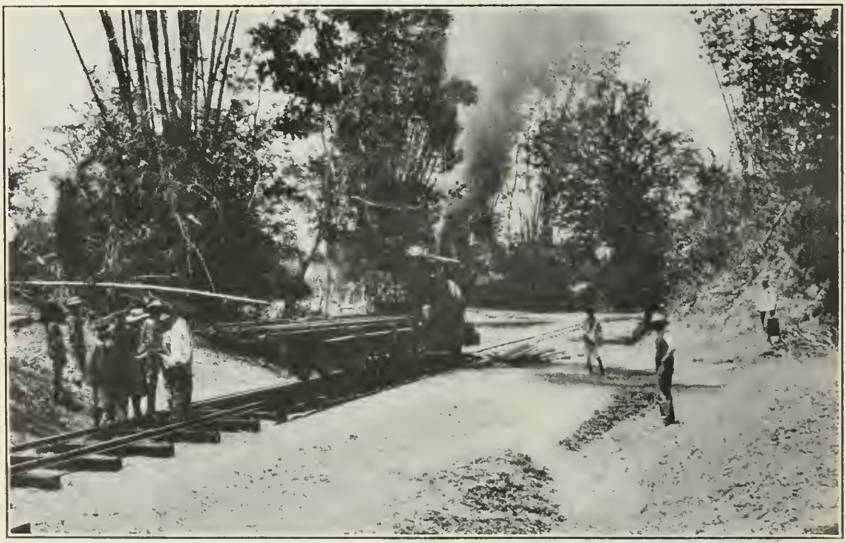


NATIVES ERECTING A LARGE SUCTION DREDGE AT ILOILO.



BUILDING A BAMBOO RAFT WITH RATTAN LASHINGS FOR USE ON CEBU SEA-WALL CONSTRUCTION.

A "Blue-Funnel" Liner is lying in the offing.



BUILDING A CONSTRUCTION RAILROAD AT ILOILO, ISLAND OF PANAY.

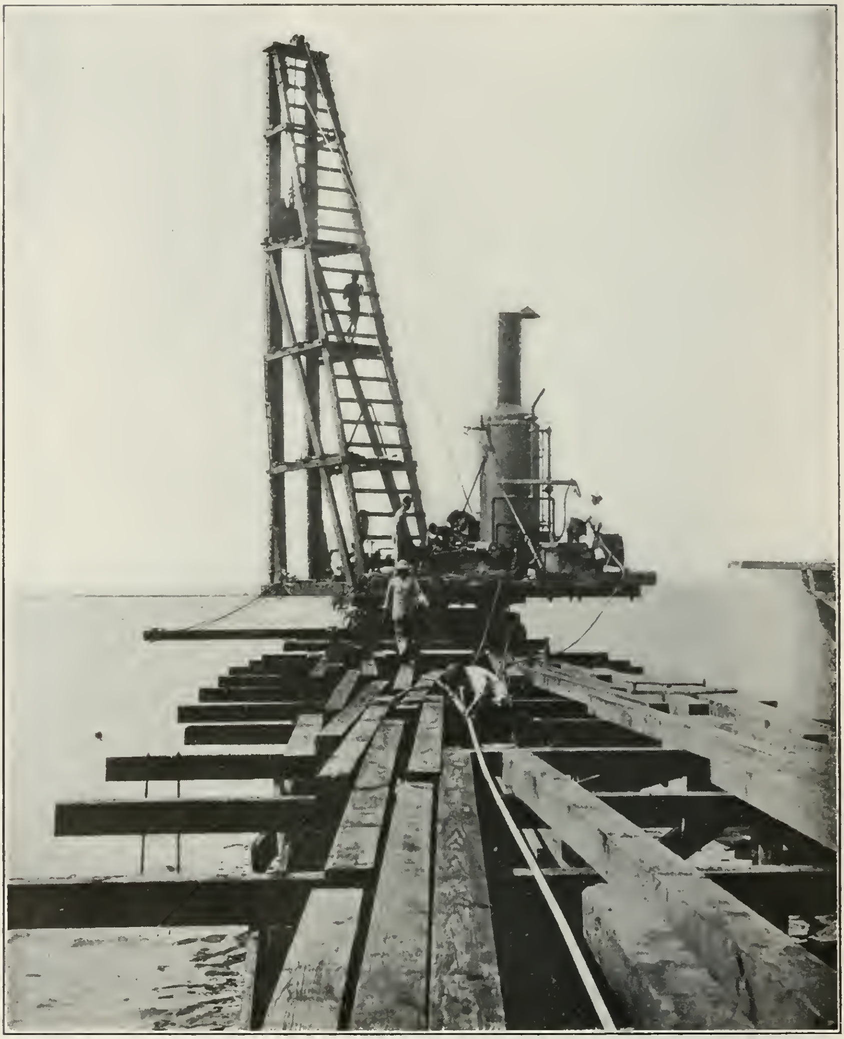
For hauling rock, sand, and gravel for the sea-wall and jetties crew, quickly put out the lights and "played possum." We finally found refuge in the house of an American teacher.

The next day was Sunday, so we rested, and in the evening our considerate host introduced me at the planters' club. The club house was attractively furnished and equipped with all the essential attributes of the Far Eastern municipal club. The representative citizens of La Carlotta, gathered here, testified in several ways to the development of the town. They showed a nice discrimination between certain brands of Scotch and American whiskey, played ably at poker, and swore precisely in English. However, the flourishing condition of many of the large plantations bore witness to the possession of stable virtues on the part of their proprietors. With suitable governmental encouragement, modern agricultural methods would doubtless be immediately accepted and instituted.

Upon completion of the inspection of Negros, we rested at Escalante, the port of Danao. Here is afforded one of the finest harbors in the southern islands. There is a bar at the mouth, the dredging of which presents no great difficulty. Within, there is a deep anchorage which will easily accommodate ten or twelve large steamers.

THE LONGSHOREMEN OF THE EAST. LOADING CASCOS WITH RICE AT A PHILIPPINE PORT.

On Cebu the route of the railroad will be along the east coast from Argao, the cable port at the south, to Danao at the north. The



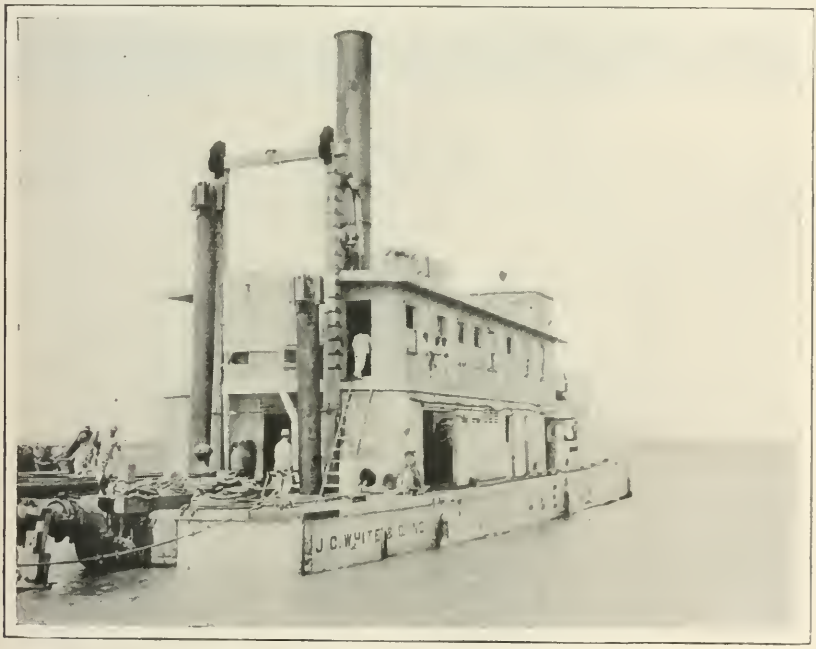
NATIVES OPERATING A REVOLVING PILE-DRIVER, ILOILO HARBOR WORKS.

town of Cebu, the metropolis of the southern islands, is located on the line about 25 miles from the northern terminals. This line, while near the coast for its entire length will fulfil about the same service as those on Panay and Negros. There are practically no harbor facilities *en route* except at the towns mentioned, where produce must be collected for shipment.

It has been determined that a 3-foot 6-inch gauge will be used, but otherwise the precise nature of the equipment of these new railroads is as yet problematical. The passenger-traffic demand would seem to be for two classes of passenger coach. Except as to gauge, the first-class passenger cars will probably not depart radically in appointment from the best accepted practice in the western world. The practicability of a second class on the system appears doubtful. The third-class cars will differ from the first in the elimination of finished ornamentation and upholstery.

The freight-traffic demand seems to prescribe cars of moderate capacity, especially in Panay. There are so many small farmers that shipment in small lots will probably be quite heavy, heavier than in large consignments during the early development of traffic.

The character of the motive power cannot be decided upon without a more minute investigation of the conditions on the ground. Then, even, it will be a matter of supplying the equipment in accordance with the demand.



THE DREDGE AMERICA. AT ILOILO, JANUARY, 1906.

The steam-railroad service of Japan at the present time is the prototype of what may ultimately be expected of the traction developments now being inaugurated in the Philippine Islands. When the pioneer phase has been consummated, there will be established a sys-

MAKING MANILA ROPE IN A NATIVE ROPE-WALK.

tem conforming in all particulars, except those of size and speed, to the best modern railway practice of the western world. Because the Filipinos are a small race, cars built to the narrower gauge are to them quite as commodious as we find our own standard-gauge. The comparison is already exemplified in substance by the Japanese railways, which are narrow-gauge. On the new Philippine lines speed will at first be very moderate, but will, of course, be subject to the constant acceleration characteristic of railroad practice in general.

MACHINERY FOR THE PANAMA CANAL—OLD AND NEW.

By Fullerton L. Waldo.

Settlement of the long-debated question of the type of canal to be built across the Isthmus will bring into immediate and most active interest the choice and installation of the mechanical equipment for the vast work of excavation. Mr. Waldo's notes and pictures are fresh from the field of recent work on the Canal.—THE EDITORS.

ONE of the most pathetic sights at the Isthmus is the decaying French machinery—the eight or nine dredges and flotilla of launches, said to have cost the preposterous sum of $22,000,000, run amuck at the "Bone Yard" near La Boca, where the Rio Grande meets the line of the canal—the steam shovels of obsolete model rotting in the jungle on tracks that are mere wisps of rust—the little top-heavy Belgian locomotives disgorging orchids at their cab-windows, with bell and whistle long ago muffled by *bejucca*-vines, and lizards sunning themselves along the footboards. A prying child can poke his finger through the iron-rust in many a place, and the footfall of a gibbering monkey crashes through the dry-rot in the wooden superstructure of machinery that in its day devoured clay banks and regurgitated like some great fire-breathing dragon of ancient fable.

At La Boca there is a dredge that cost the French $250,000. The Canal engineers have decided it is not worth the $100,000 it would take to put it again into commission. As you go in a little launch from Colon to Bohio along the silted-in quarter of the Canal dug (1884-1888) by an American company in the service of the French, tugs stranded at the bankside with their decks awash and funnels canted dangerously tell the same story of lavish expenditure which ultimately served no useful end. Much of the French machinery, Mr. Morison suspected, was built simply that it might be sold to the gullible; nobody knows, today, how it was used, if indeed it was ever used at all.

All railroad track laid by the French company was laid with the light Belgian rail, 3¾ inches wide at the base and 4⅞ inches high, in 6-metre lengths. The relaying of the main line of the Panama Railroad by the Commission with 70-pound per-yard rail (as compared with 50-pound) in 33-foot lengths, is just about completed. The engineers at Culebra resurrected from the jungle fifty-

"OFF AGAIN."

eight of the Belgian locomotives and put them in commission. Nine hundred and eighty French dump cars were overhauled. In many cases it was necessary to build tracks into the jungle to fetch them out from where they stood overgrown with creepers, the original roadbed having been reclaimed long since by tropical Nature. The Commission has been economical; it has utilized every bit of the old French machinery that could be used; the repair shops at Cristobal, Bas Matachin, Empire, and Culebra have repaired a lot of it. A large dredge left at Cristobal was reconstructed and put in commission; at La Boca a 300-yard self-propelling barge was re-built, as well as a 300-ton lighter and two 55-foot steam launches. Before the new steam shovels began to be delivered on the Isthmus, many of the old French excavators of the chain-and-bucket type were reconstructed and successfully operated. The last French excavator at Culebra was discarded June 16, 1905. By June 30, nineteen of the new American steam shovels were at work. The French excavators had in clay attained a daily output of nearly 1,400 cubic yards, but according to the records of the Commission their performance in rock has not been so satisfactory as that of the American shovels.

MACHINE SHOPS AT GORGONA.

The equipment purchased by the Commission and contracted for, for delivery not later than June 30, 1906, includes:—

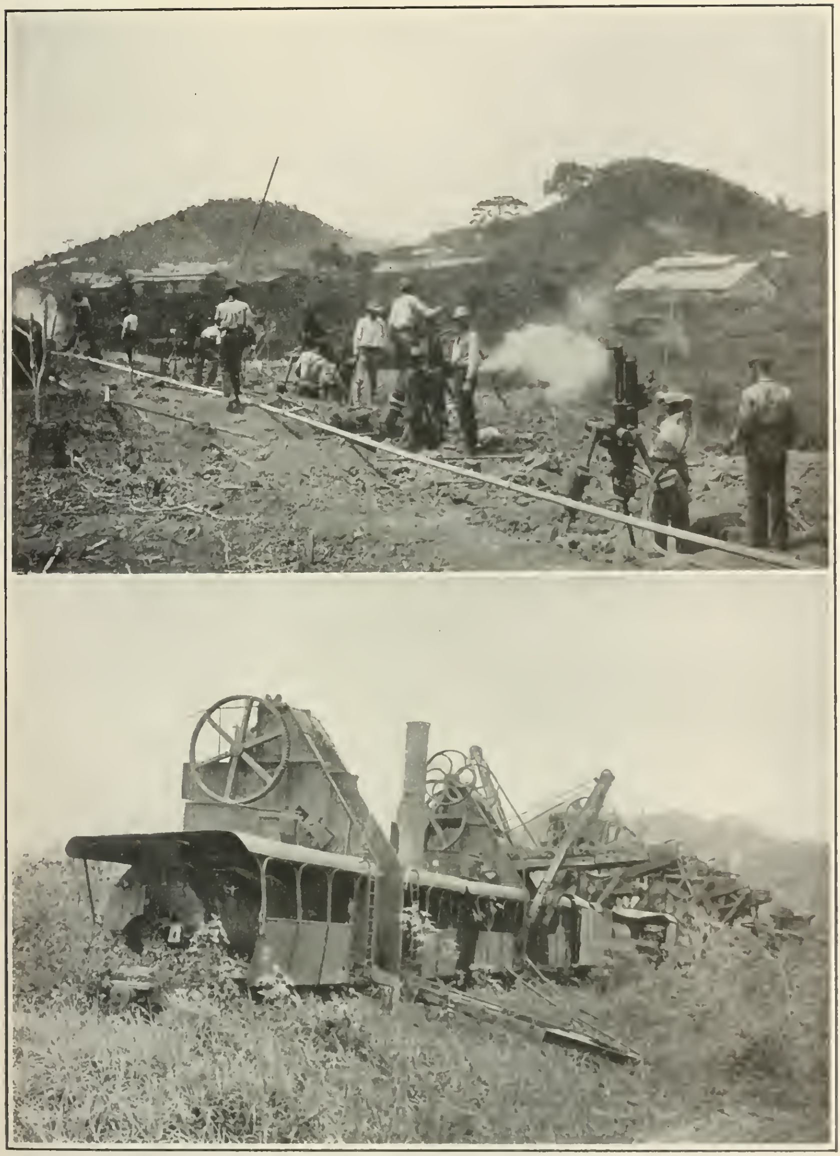
1,100 steel flat cars	$1,071,100
120 locomotives	1,367,000
43 steam shovels	493,600
18 unloading machines (plows, etc.)	151,794
3 water tanks and towers	36,050
3 earth spreaders	23,382
2 dipper dredges	205,000
Miscellaneous	2,074
Total	$3,350,000

In their entirety, the more important machinery items of the original order, for preliminary work and permanent plant are as follows:—

Ocean steamships	2
Steam shovels	61
Locomotives	120
Flat cars	1,300
Dump cars	324
Rapid unloaders	12
Unloading plows	22
Earth spreaders	13
Dipper dredges	2
Steel barges	11
Stone-crushing plants	2
Air-compressing machines	14
Cranes	3
Rock drills	152
Portable deep-drilling machines	30
Hoisting engines	12
Dumping wagons and other vehicles	135

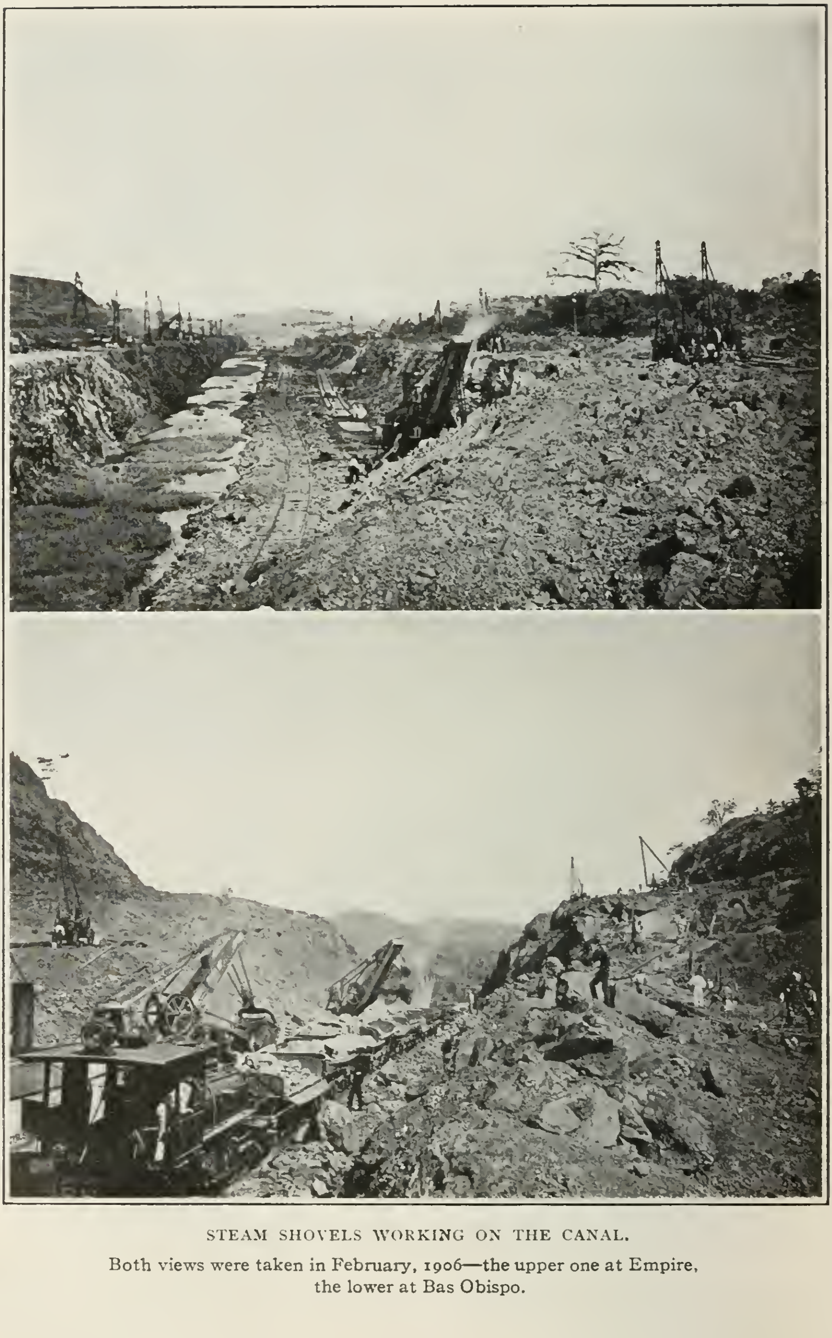
The approximate total cost of purchase of these and other items was $9,000,000.

The sixty-one steam shovels, the three wrecking-cranes, and one pile-driver, were built by the Bucyrus Company. Thirty-two of the shovels are 95-ton; twenty-eight are 70-ton; one is a so-called New-45. Two of the wrecking-cranes are 75-ton, the other 100-ton. The 95-ton shovels carry a 5-yard dipper, and, with their incisive teeth, are admirably adapted to handle the hard, indurated clay of the benches of the Culebra cut. The report of the Commission says (p. 296):—"The operations of the shovels have been entirely satisfactory, and they have already proved themselves to be machines of high efficiency. Indeed, the results so far attained indicate that there is no other type of machine better adapted to the class of work to be done in the summit cut, or which can reach a greater efficiency." The bucket-and-chain shovels of the French required a great deal of blasting. The 95-ton American shovels, despite the occasional strata of hard clay (there is no granite on the Isthmus) handle the Culebra



MACHINERY, OLD AND NEW, ON THE LINE OF THE CANAL.

Both scenes are at Paraiso. The lower one represents old and abandoned French excavators; the upper shows American steam drills at work in February of this year.

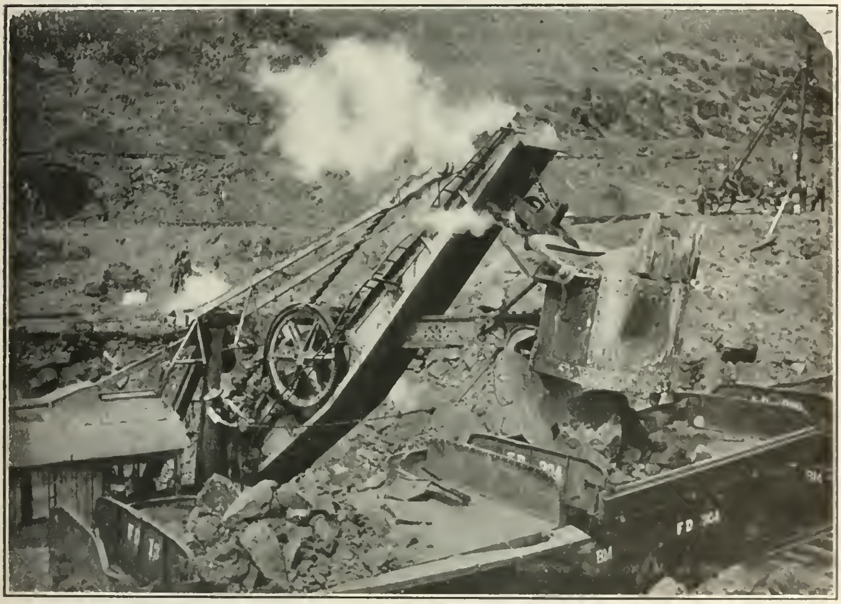


STEAM SHOVELS WORKING ON THE CANAL.

Both views were taken in February, 1906—the upper one at Empire, the lower at Bas Obispo.

material with a comparatively slight amount of assistance from the dynamite candle.

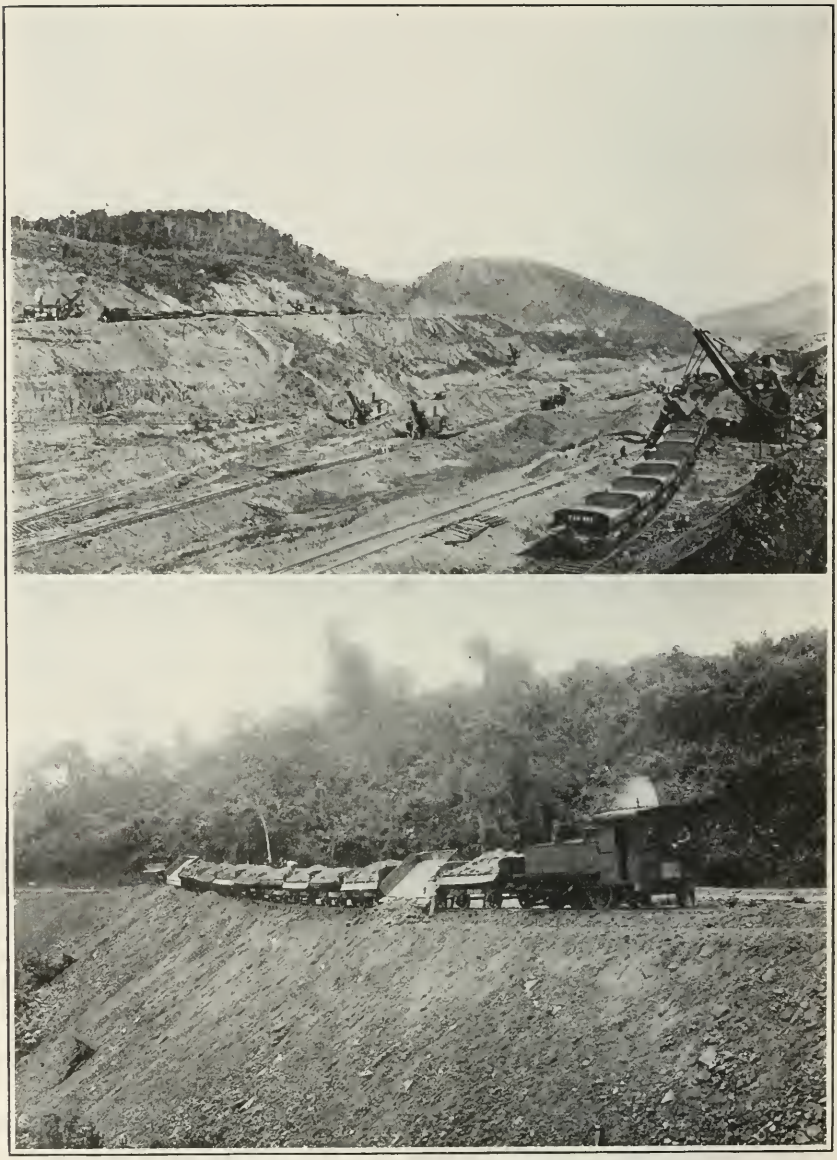
The 70-ton shovels have 3-yard dippers and are used largely in minor cuttings along the line of the Railroad. The New-45 type has a 1¾-yard dipper, and because of its superior mobility is employed on wash-outs, which are embarrassingly frequent in the rainy season. The wrecking cranes and the pile driver are just like those used by the railroads in the United States. The 95-ton shovels and the 125-ton crane are the most powerful machines of their respective types that have ever been constructed.



THE BUSINESS END OF A 95-TON STEAM SHOVEL

Main engines have 14 by 16 in. double cylinders; independent reversible engines control the thrust motion of the boom and the swinging gear; locomotive boiler, 14½ ft. by 66 in.; clear lift from rail to bottom of dipper door, open, is 17 ft.; width of cut at 8 ft. elevation is 62 ft. Car is 41 ft. 7 in. by 10 ft., with four 20-in. I beam sills; two propelling chains, for forward and rear trucks.

A moving crane on Dock 14 in Cristobal and a stationary crane on Dock 11 have recently been installed and are doing excellent work in dredging on the channel. Dock 11 is used by the very largest ships, and each dock accommodates two vessels. Two hundred and fifty feet of dredging will give a 27-foot channel alongside the docks. Under the French *régime*, much of this sort of dredging was done with gross carelessness or reckless extravagance. For instance, a



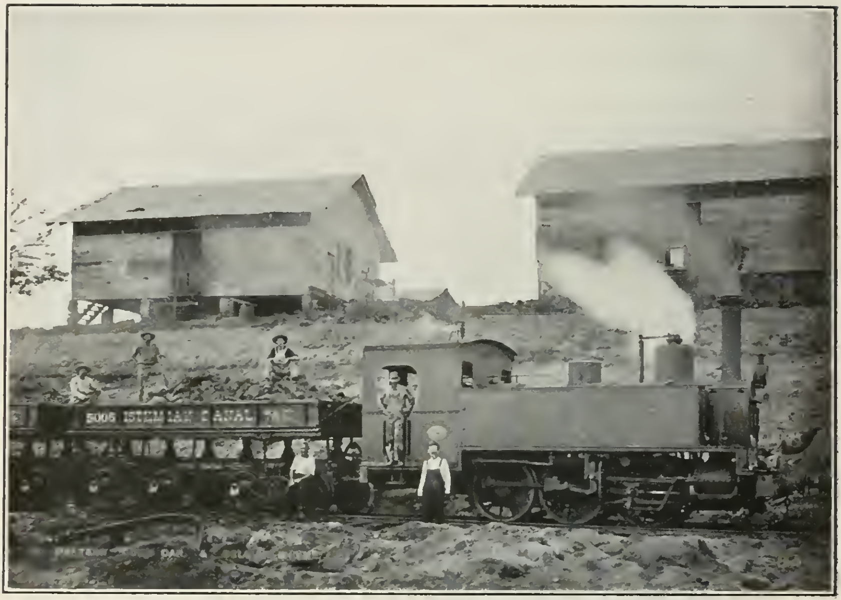
A GLIMPSE OF PRESENT WORK AT THE CULEBRA CUT.

The upper view shows some of the shovels installed in the great cut; the lower is one of the dumps.

locomotive stood simmering on a siding at Colon, in charge of a caretaker who didn't know a throttle from a bell-rope. "I want to dredge there!" yelled the engineer of the dredge in the channel brandishing the boom and rattling the hoisting-chain to scare away the fellow on the locomotive. The caretaker refused to budge—probably because he didn't know how to move the locomotive. With an oath, the dredge engineer attacked the bank; the man on the locomotive jumped to the crumbling and caving-in red clay; and presently the locomotive was a ruin under the teeth and claws of the dredges as the siding—rails, embankment and ties—slid into the stream with their costly burden of highly specialized machinery.

AMERICAN DOCKS AT CRISTOBAL.

Some of the dredges during the French era made a practice in dredging the clay of throwing the spoil from the excavation directly beneath themselves, so that it all had to be rehandled, at a vast profit to the contractors. That is the great trouble with most of the digging the French did—they dumped the dirt on the spot, like a child digging holes on the beach, instead of taking the trouble to convey it to a distance. They used dump-cars opening on one side only, which entailed endless inconvenience in switching. In wet weather the clayey material sticks to the French cars, and has to be shoveled out by hand. Though we are using many of these French



ONE OF THE BELGIAN ENGINES WITH A MODERN DUMP CAR.

dump-cars at present, we are supplanting them as fast as possible with the Western dump-cars everywhere in use for similar purposes in the United States. It is probable that much of the work will be done later by loading the spoil on flat cars and plowing it off.

Of the smaller machinery used in the all-important work of making borings to determine areas of probable feasibility for the location of dams, a resident engineer in charge writes the author:

> "In getting borings the diamond drill was used in almost every case. The wash rig equipment consists of a tripod derrick with a wheel drum. Hollow wash rods (1⅞ in.) were used for drilling, through which water was forced by Rumsey or Gould 2½-inch hand pumps. For cutting, a bit was used with four jet holes. In clay or clayey soil it was often possible to run the rods down without casing, but for diamond-drill work, and in sand or gravel, 2½-inch casing was used and set into the rock to cut off the flow of sand or outside material. The diamond drill was the ordinary tripod machine, with 1 5/16-inch bit set with six to eight carbons, cutting an annular ring so as to leave about a 1-inch core. Usually three wash rigs and one diamond rig were running. For the river work, two rafts were built of balsa wood. . . Whenever it was possible, platforms were built in the river with old rails, and were quite serviceable, as this made it possible to use the diamond drill. It was found risky to use the diamond drill from the raft. The 2½-inch casing furnished was in some instances very carelessly threaded, and often so far out of center that the female thread which broke was often but one millimeter out of a total pipe thickness of 6 millimeters. At least six holes were lost by the casing twisting off, as it was often not easy to detect the defect."

The great trouble up to the present has been, succinctly put, that requisitions for machinery and men qualified to use it have not been

ONE SIDE OF THE CULEBRA CUT.

A RUNAWAY STEAM SHOVEL.

honored—tools and track implements have been stored in Government warehouses instead of being put into the hands of the men in the field—entirely too much dependence has been placed by the Government on the prospect of using the rotten and obsolete mechanical *transmittenda* of the French Panama Canal Company, a prospect encouraged by an exaggerated notion on the part of the Isthmian Canal Commission as to the value of the machinery.

AN ARMY VIEW OF AMERICAN GOVERNMENT ENGINEERING.

By Major Wm. L. Sibert, Corps of Engineers, U. S. A.

Major Sibert's discussion, like Mr. Waldo's just preceding, bears closely upon the leading topic of engineering interest—the practical construction of the Panama Canal. In the cause of fair play, we are glad to present this view of the efficiency of Government control of engineering construction as it appears to its friends. And in this connection we would point out that the system ably defended by Major Sibert is very close to that which we have always advocated for the Panama Canal—the commitment of the actual work wholly to contractors, under Government-prepared specifications and under Government inspection. Every instance of success he cites is an argument for the extension of the same common-sense policy to the larger work now about to enter upon its most active phase.—The Editors.

HAVING noted in one or two periodicals a tendency of late to criticise the methods followed by the Government in carrying on construction work, such criticism citing, in particular, the river and harbor work of the United States—a work prosecuted by the engineer department of the Army—I feel it only fair to that department and to the Government that the people and the engineering profession should have some data upon which to base an unbiased opinion upon this question.

It should be stated in the beginning that there are no political offices in the engineer department at large. All of the employees in that department enter it in accordance with civil-service rules and regulations, and such rules and regulations are carried out by men in sympathy with their intent. It should also be stated that the river and harbor improvement in the United States is done almost entirely by the contract system. Occasionally work of some magnitude is carried on by hired labor. This, however, is the exception and not the rule. The law requires that contracts be let to the lowest responsible bidders and gives the contracting officer the right to cause the lowest bidder to establish his ability, both financially and otherwise, to do the work.

The corps of engineers referred to above built all permanent fortifications for the defense of the harbors of the United States, and it is thought that the character of this work will speak for itself in the next war, if any attempted naval invasions of such harbors occur. As to the river and harbor work, it is thought the fact that the navigable capacity of the great harbors of the country has kept pace with the increasing commerce entering such harbors, is forceful evidence of duty well done by those responsible for such improvements. The successful planning and constructing of the ship channel in the connecting waters of the Great Lakes, including the St. Mary's Falls and the St. Clair Flats canals, have resulted in the greatest freight movement on any inland waters in the world, and have made possible the present wonderful steel and iron development in the Pittsburg district and on the Lakes. Such rivers as the Monongahela and Great Kanawha have been completely improved, and the amount of commerce, 12,000,000 tons annually on the Monongahela and over 1,000,000 tons annually on the Kanawha, does not seem to indicate inefficient management of such improvement. The improvement to the entrance to Galveston harbor, increasing the usable depth of that harbor from 9½ feet to 27½ feet, in consequence of which Galveston has become the second or third city in the United States in the value of material exported, speaks for itself. It is thought that an examination of the above works and of many other similar works, and of the lighthouses along the shores, will cause such works to be placed among the better grade of achievements of the engineering profession throughout the United States.

While it is true that the system followed in a considerable portion of this work has been rather " hit and miss," this system cannot be charged to any branch of the executive department of the Government, the duty of such department being to execute the laws enacted by Congress. Neither can the system be charged to the River and Harbor Committee of Congress, nor to Congress itself. Committees of Congress study carefully the particular lines concerning which they recommend legislation, and are nearly always ahead of Congress itself. It is thought by those who have had the opportunity to judge that this is particularly true of the River and Harbor Committee, which has labored hard to eliminate unworthy projects and to provide funds to carry on properly the great river and harbor works of the country notwithstanding adverse, and sometimes selfish, public opinion. Congress must conform to public opinion. The system, therefore, as defined by the laws enacted by Congress, is the product of public opinion, and if the system be faulty, the newspapers, the magazines, and the people generally are responsible. Those who criticise most the faulty system are many times the first to denounce a proper River and Harbor Bill as a " pork barrel."

There are many important river and harbor projects throughout the United States. To carry on the work of all of them in a systematic and businesslike way would cause a material increase in the appropriation carried by the River and Harbor Bill—a greater increase, indeed, than public opinion at present would permit. In fact, public opinion, if retrenchment is necessary, always says, first, "cut out the River and Harbor Bill;" it always says, second, "make it of such and such a size;" which means that it is impossible to carry on the various pieces of work under way in a businesslike manner.

After a proper system has been determined upon and the necessary funds for carrying out the work in accordance therewith have been provided, the agency responsible for its execution is properly chargeable with any neglect or delay, and not until then.

The laws, and the rules and regulations framed in pursuance of laws, governing the expenditure of public funds, are drawn especially for the purpose of preventing any government employee, responsible for the plans of the work or for the disbursement of public moneys in connection therewith, from having an interest in any contract involving the execution of such work, or from having an interest in any firm furnishing material for such work, or from accepting a commission for supplies of any kind purchased in connection with such work; and it is thought that these laws and regulations should be as they are, so as to prevent in the future, as they have so well in the past, the above evils. Beyond this, it is doubtful whether there is as much red tape connected with the transaction of the business of the engineer department at large as there is in some of the great corporations of the country. This, of course, assuming that a man wants to do business with the means available, and is not looking for technical difficulties to block his work. If he is looking for such difficulties he can find them in the engineer-department methods as well as in those of private corporations.

Actual examples constitute the best data upon which to base an intelligent opinion, and the writer having personal knowledge of the following, cites them as samples of work practicable under the methods of the department in question.

The last River and Harbor Bill, approved March 3, 1905, contained, among others, the following appropriations for river and harbor work in the Pittsburg District:

First.—An appropriation of $500,000 with authority to enter into contracts for $1,281,376 more for the completion of Locks and Dams Nos. 2, 3, 4 and 5, Ohio River. Knowing beforehand from the Committee reports that this money would probably be appropriated, the designs for the work in question had all been worked out and forwarded to the Chief of Engineers for action prior to the enactment of the law. Such designs were forwarded by the district officer, through the division engineer, to the Chief of Engineers. They were passed upon, probably in amended shape, subject to an appropriation by Congress. The district officer received notification on March 15, 1905, of the passage of the River and Harbor Bill, and was called upon for a proposed scheme of execution. This was forwarded to the Chief of Engineers, through the division engineer, on March 21, 1905, and returned approved on March 28, 1905. All the contract work involved in the expenditure of the above money, that would take more than two seasons to accomplish—working seasons on the Ohio River being short—was advertised on March 17, 18, and 20, 1905; bids opened on April 17, 18, and 19, 1905; contracts entered into on May 4, 6, and 24, 1905. After that, of course, the execution of this work by the contractors would be the same, whatever the agency directing the work. The money was appropriated on March 3, 1905, the district officer notified March 15, 1905, all the contracts let and work commenced on May 24, 1905.

Second.—Improving Monongahela River, building Lock and Dam No. 3, $200,000 appropriated, contracts authorized for $389,196 more. Notification of the appropriation was received on March 15, 1905. This was a new piece of work to be built for the purpose of replacing an old lock above that was in poor physical condition. The work was urgent, since about 10,000,000 tons of freight passed through the old lock each year. It was necessary in this instance to purchase land, obtain a clear title, and have the same passed upon by the Attorney General before any work could start. A deed was obtained on May 16, 1905, and forwarded to the United States district attorney, the delay being due to the many mortgages on the large tract of land of which this property was a part. It was forwarded by the United States district attorney to the Attorney General's Office in Washington on May 22, 1905, passed upon by that office May 25, 1905, the assistant attorney general having been informed as to the urgency of the work. The work was advertised on April 27, 1905, bids opened May 27, 1905, and contract entered into on June 21, 1905. After that the rate of prosecution was dependent upon contractors working under the contract.

Third.—For building Dam No. 2, Allegheny River, and completing the lock, for which work contracts were authorized aggregating

$281,226.63. Notification of the authorization was received on March 15, 1905, work advertised on March 17, 1905, bids opened April 17, 1905, and contract entered into on May 2, 1905. These constitute the main items of new work authorized in the Pittsburg district by the River and Harbor Bill approved March 3, 1905. Other work was of course being done in pursuance of contracts authorized before that date.

If the methods of doing business in the engineer department at large permit in one district the placing of work under contract in the time specified above, they do in all; and it is thought that few of the larger corporations of the country have methods of administration that would permit placing the above and similar work under contract in less time. The regulations require, in the general case, an advertisement of 30 days, in order that everyone who desires may have an opportunity to bid. The above examples seem to indicate that an officer directly in charge of work in the engineer department can do practically anything necessary for the proper prosecution of his work so long as he is honest in his intentions and is trying to further the best interests of the Government. When a plan and project have been approved by the chief of the department, the district officer is then practically free in their execution, being governed, of course, by the laws and regulations drawn for the purposes referred to previously in this paper.

The ordinary routine of the work is carried on by the district officer directly with the Chief of Engineers. The division engineer is an intermediary only as to plans, projects, and primary methods of procedure. He is an advisory engineer, and the district officer is free at any time to call upon him for consultation or advice.

It is thought that one should be loath to conclude that the United States can not perpetuate itself—that Congress has not the wisdom to enact laws that will permit the great departments of the Government to perform in a businesslike way the functions of government, such performances being essential to progress and including the prosecution of the great works of improvement.

ECONOMICAL EQUIPMENT AND MANAGEMENT OF THE DRAFTING ROOM.

By Thomas Doane Perry.

One of our contributors said recently that the drafting room "should lead the shop, not follow it." While he was speaking rather of executive functions, the statement may be applied to administrative methods. It should certainly be a model of reasonable and common-sense system. Mr. Perry offers not only an argument for but an example of modern organization at this possible fountain-head of shop economy.—THE EDITORS.

THE need of economical management in the drafting room is a matter of increasing importance in this day of keen competition, when even the proper conversion of by-products into marketable form may be a determining factor in the dividend account. The old way of charging the cost of drafting-room maintenance against the general-expense account in a lump sum is gradually yielding to modern methods and consequent detailed analyses of such costs and systems, with a view to placing them and keeping them on an economical basis. The American tendency of going to extremes has been manifest in these analyses, and has often resulted in the compilation of expensive records which are unused and unusable. Discrimination and reason, however, are coming to be exhibited in the successful engineering and manufacturing concerns of today, and the analytical process is bringing about much needed economy in the drafting room.

The importance of starting right should be uppermost in the minds of those who are beginning their engineering career as draftsmen, that they may form good habits along these lines. Those who are organizing drafting rooms or already have them under their control should also realize the need of a systematic beginning, because there is no more serious obstacle to the establishment of economical methods than that often found in an accumulation of irregularly made and unclassified drawings and data.

The suggestions embodied in this article are outgrowths of attempts on the part of the writer and others to meet the above conditions in a practical way—i. e., to arrange and preserve systematically, and in a manner at once simple and economical, the various classes of drawings and information that accumulate in a drafting room. If the method is such as to be serviceable for either a single draftsman or a large department, it will allow growth without such changes and readjustments as are often the cause of confusion and loss. These methods as explained have special reference to plans for machine construction, but permit of ready adaptation to most drafting-room work.

The functions of the drafting room are two; the making of working plans and drawings that shall serve as intelligent guides to the carrying out of projects in hand, and the storing and preserving of the originals of all such working drawings, together with accessory data and any preliminary sketches of value, in a form that may be easily and quickly consulted. At best the drafting room must be carried on as an expense item, and therefore should be so organized as to secure the highest efficiency at the lowest cost consistent with the fulfilment of its functions.

In view of the fact that the making can be advantageously modified to accomplish the preserving, the methods of filing and storing will be taken up first. This order of treatment will indicate more clearly the reasons for the methods suggested later in the making of drawings.

There are three methods of filing in general use: vertical, flat and roll. In times past draftsmen have been quite prone to use one to the exclusion of the others, but as a matter of fact each one is especially useful for a certain size or class of drawings.

In both vertical and flat systems of filing it will be found of decided value to group together in folders such papers as naturally relate to each other. A folder will accommodate conveniently from ten to twenty-five drawings, grouped according to some of the following systems; alphabetical, numerical, geographical, by subject, etc. A folder should be labeled clearly for convenient reference, preferably upon the projection. The projections should be about ½-inch high and one-fourth or one-fifth as wide as the body of the folder. Where subject to frequent handling these projections should be reinforced with paper, cloth, or metal. Fold-

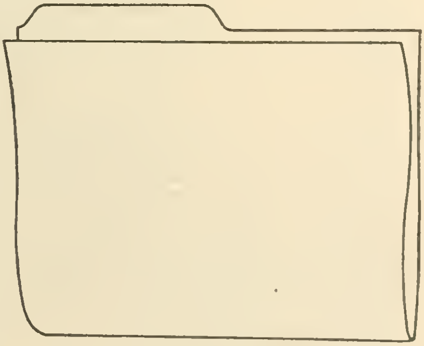


FIG. 1. FOLDER FOR DRAWINGS.

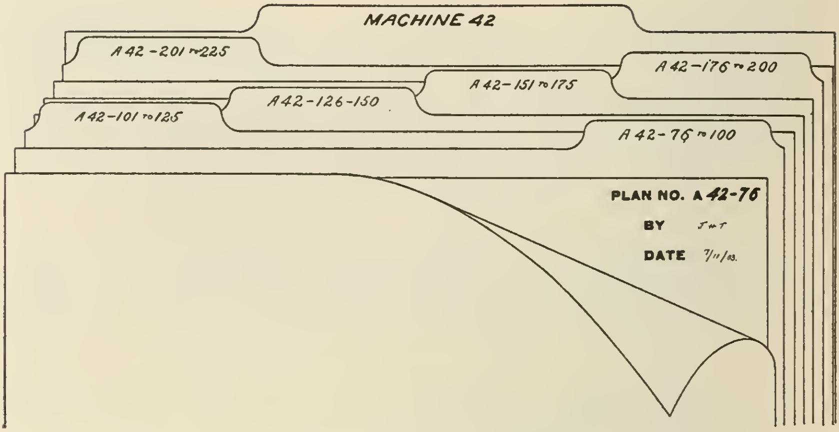


FIG. 2. VERTICAL FILING, SHOWING METHOD OF MARKING GUIDES, FOLDERS, AND DRAWINGS.

ers may be had in various colors, and this may be made the basis for a classification, such as blue for prints, manila for tracings, salmon for sketches, etc. It is usually advisable to have separate compartments for each of these classes, though in a small drafting room it is sometimes convenient to have everything pertaining to a certain set of drawings together. Folders should be made of tough stock about .01-inch thick to give necessary strength without being too bulky.

Vertical filing, a system extensively used for correspondence, is a method that may be adapted to the economical and efficient filing of plans and drawings. In brief, the method is one in which papers are grouped in single folders, such folders standing vertically on their folded edge in long drawers. Some of the features that make vertical filing valuable are: the extreme ease with which a large amount of material in a single drawer may be consulted without removal, the facility with which papers may be classified, arranged, and indexed, and the fact that there is no other method of filing known that will accommodate the same amount of material in a given cubical space. This way of filing lends itself very readily to the needs of the drafting room for everything not over 9 inches by 15 inches, and by the judicious subdivision and reduction of larger drawings a majority of them may be made to conform to the requirements of vertical filing. Each drawing should be marked or numbered clearly in the upper right-hand corner. The use of guides is necessary, and their frequency depends upon the style of classification used. It is well, however, not to have more than ten folders between guides. Guides are somewhat higher and stiffer than folders, with a similar projection, and have near the lower edge a metal eyelet which travels on a rod in the drawer and prevents the guides from rising out of position. Stiff manila stock about .02-inch thick is generally used for guides, although the most durable are made of red fibre and called press board. The vertical filing of drawings larger than 9 inches by 15 inches is not practicable except where they are made upon very heavy board, and would require the construction of special cabinets.

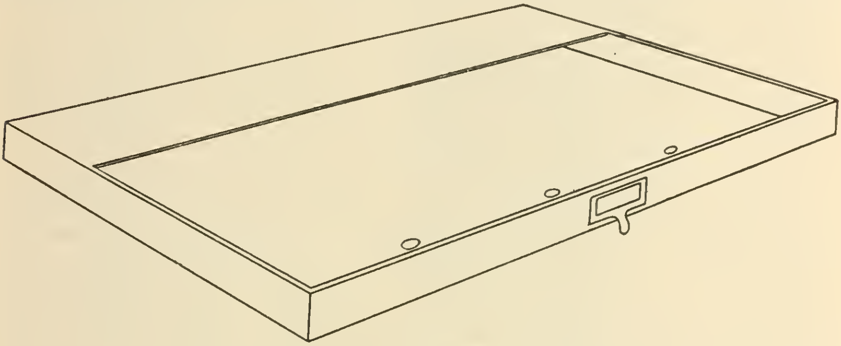


FIG. 3. DRAWER WITH HOOD AND FINGER HOLES.

Flat filing in drawers, almost universally used in drafting rooms, has its limitations. It may be made serviceable for drawings between about 9 inches by 15 inches and 32 inches by 40 inches. Of course it may be used for even smaller drawings, but is much less convenient than the vertical file. Its most serious objections are: the difficulties of keeping together such drawings as relate to each other, of removing such as may be required, of returned drawings to their proper places, and the damage to corners and edges of drawings which causes many exasperating delays. These objections may be overcome to a great degree by the addition of a few labor-saving devices. A hood over the rear 6 inches of the drawer top will do much to prevent papers from curling up over the back of drawer, and several finger holes through the drawer bottom near the front will make it easy to remove drawings, or to refer to the marks or numbers which should be in the lower right-hand corner. The sys-

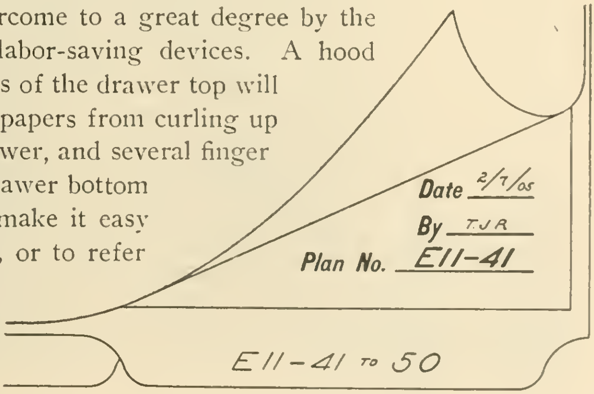


FIG. 4. HOW FLAT DRAWINGS SHOULD BE MARKED.

tematic grouping together in folders as previously outlined will be found of particular assistance in flat filing. The removal of a folder as well as its return to its proper location is an easier matter than the removal of a single drawing, and the drawings are less likely to be damaged in handling. To facilitate removal flat folders should be made of stock with a smooth surface. The folder projections, if there are only a few folders to a drawer, may be located in the lower right-hand corner; if more than half a dozen it is advisable to distribute them along the edge of the folders nearest the drawer front. Folders should be only a trifle smaller than the drawer on all sides, to prevent shaking around and the lapping of the labeled projections. The drawers should not be more than 2 inches deep. Occasionally the use of heavy press-board guides between groups of folders will facilitate the separation and finding of certain classes of drawings.

The objections to rolling, when applied to large (over 32 inches by 40 inches) drawings are not nearly so serious as in the case of smaller sizes, because a large plan can be unrolled and consulted with reasonable ease, and the construction of racks for rolls is inexpensive and economical of storage room. In fact, there seems to be no other way of accommodating such large drawings, as drawers of sufficient size would be awkward. The practice of folding drawings and filing in pockets or envelopes is a relic of the past, and is a clumsy and inconvenient method at best. In what has been said about rolling and folding, reference has been had to such original copies as are to be kept in the drafting room. The folding or rolling of prints or sketches for purposes of transportation is advisable, whenever necessary. But for working shop drawings there are obvious advantages in drawings of such a size that they can always be kept flat.

Filing cabinets, substantially and artistically made, for both vertical and flat filing, are quite generally on the market. It is good economy in furnishing equipment for a drafting room to adjust its requirements, as far as possible, to such "ready-made" articles as may be easily purchased. This makes systematic expansion of the department possible at reasonable cost, providing supplies have been obtained from such well established concerns as make interchangeable styles, and can furnish additional parts as desired. Special cabinets can be made to order but will cost considerably more than corresponding stock goods. Filing cabinets come in what are known as upright and horizontal units or sections. The upright units are about 60 inches high and from 12 inches to 24 inches wide, and so are convenient for frequent reference, but are economical of neither wall nor

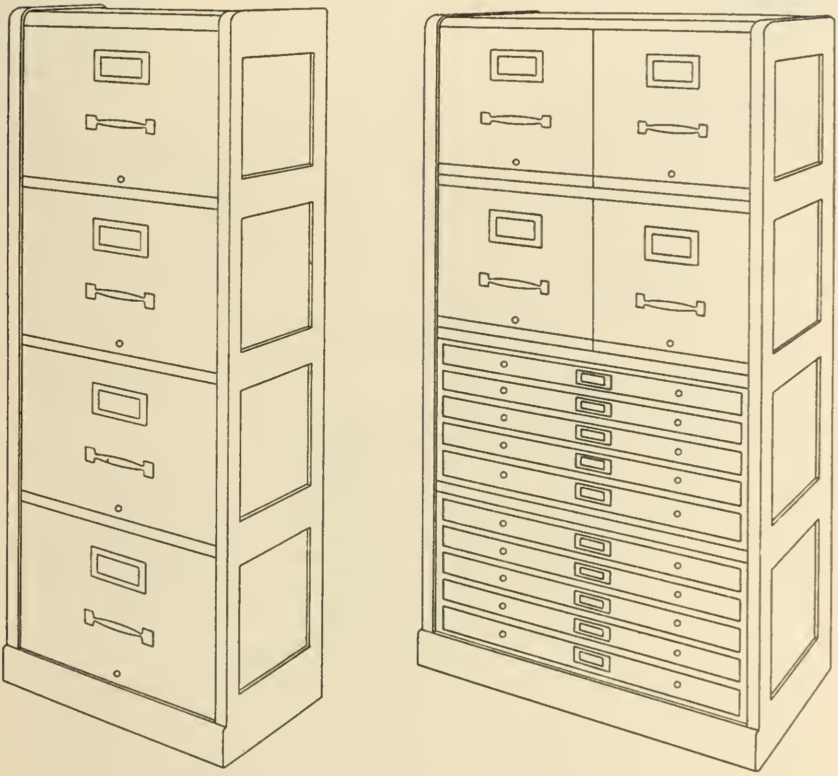


FIG. 5. VERTICAL UNITS FOR FILING CABINETS.
Indicating the possibilities of varied arrangement in each unit.

floor space. Horizontal units come about 36 inches long and 12 inches high. They may be stacked in tall tiers and are better for the storing of papers than for current use. Both styles provide for about 18 inches of filing space, front to rear. Drawers in vertical filing cabinets are made to accommodate approximately the following sizes of folders: 6 inches by 9 inches, 7 inches by 10 inches, 9 inches by 12 inches, and 9 inches by 15 inches. Such styles of vertical files should be chosen as make use of all the available drawer space. (Some styles take considerable room for follower blocks, etc.) The sizes of flat filing drawers have not as yet been reduced to what might be termed standards, but are made in various sizes up to 18 inches by 25 inches. Larger than this must be made to order. It is possible and often desirable to have both vertical and flat drawers in the same cabinet, but this depends upon the needs of the individual drafting room. Office equipment of all descriptions comes to such an extent

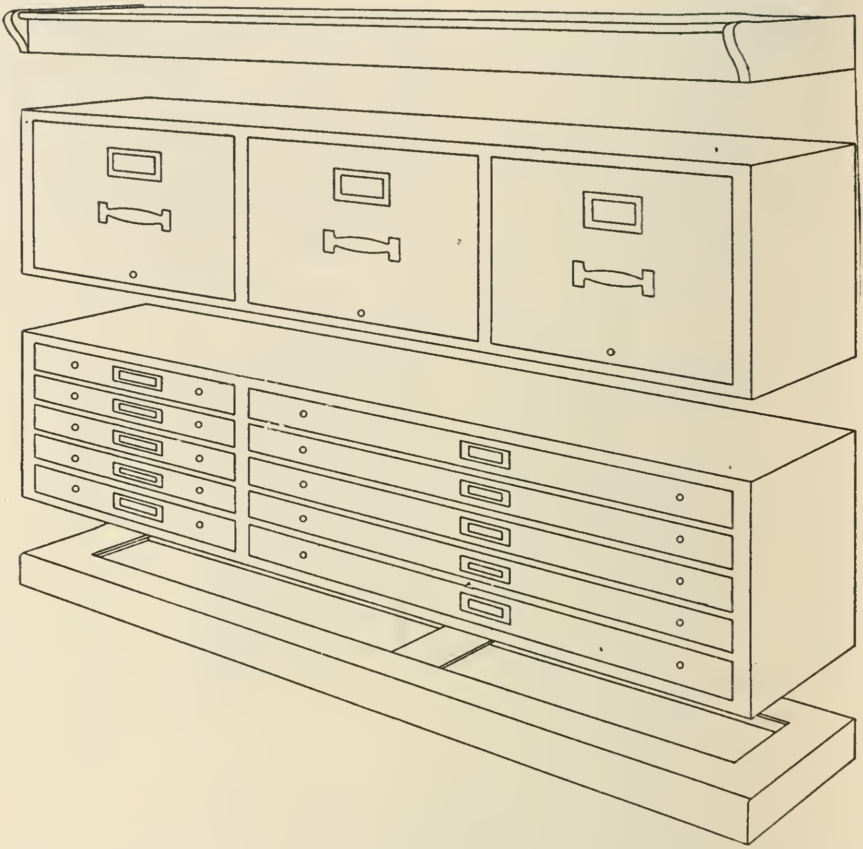


FIG. 6. HORIZONTAL SECTIONS WITH BASE AND TOP.

in interchangeable shapes as to permit almost any desired arrangement or combination.

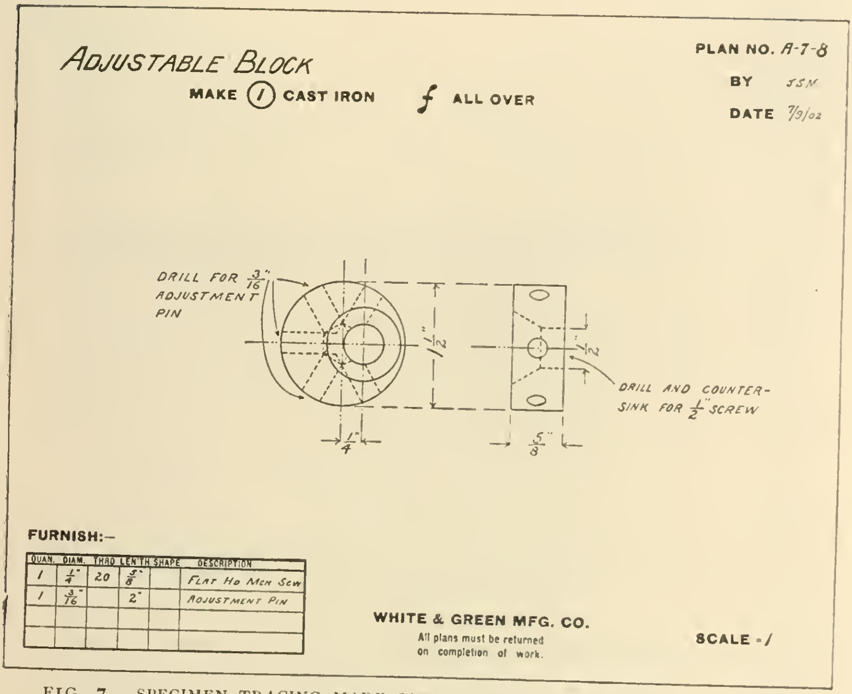
In the discussion of the making of drawings, the arrangement, size, materials required, method of numbering, system of indexing, mechanical aids, and economy of labor are the chief subjects to be considered.

The custom of crowding together as many detail drawings as possible on one sheet is most unfortunate and unwarranted, and yet it seems to have come into quite general use. Such a custom is expensive and tends to create endless confusion in the filing of drawings in the drafting room, and in the assignment of work in the machine shop. I have often noticed wastefulness caused by this confusion in the following ways:—several machinists going to and fro consulting the same drawing; a large sheet of details cut up into a variety of irregular shapes and sizes for proper assignment, with the result that plans and parts are often lost; and several draftsmen waiting to refer to different parts of the same sheet of details. Large drawings are always awkward in a shop, as they are inconvenient to use after having been either folded or rolled. The best modern practice is to put one complete detail drawing on a sheet, and let that sheet be of a size consistent with rapidity and accuracy on the part of the draftsman, and suitable for the economical shop production of the work specified. This sheet should contain all the instructions necessary for the completion of the work, and should be legibly numbered for the convenience of all departments. This practice permits the same detail to be used in a number of different machines, without duplication of drawings or other confusion.

The selection of a series of standard sizes for drawings is usually determined to a large extent by the character of the work done and other conditions existent in each drafting room. It is nearly always possible to make the size most frequently used conform to some one of the regular sizes of filing equipment described, and call this the base or unit size. Whenever practicable this should be less than 9 inches by 15 inches, that the greater part of the drawings may be filed vertically, for reasons previously given. Draftsmen should understand thoroughly the advantages of making all drawings of this unit size, in all cases where accuracy and clearness of detail are not sacrificed. Larger drawings usually may be reduced or divided into sections for the purpose of conforming to this unit size. Such uniformity will greatly simplify the filing problem. It will be necessary, however, to have larger drawings, and in the absence of other limiting conditions, the following arbitrary rule for determining a series of standard sizes will be found quite satisfactory; that the larger sizes be multiples of the base or unit size. E. g., a suitable size for small machine details is 8 inches by 10 inches, which is ordinary letter size, and easily accommodated in the 9 inches by 12 inches vertical filing drawers. This size is convenient for both draftsman and machinist. The series of standard sizes with this as a base would be 8 inches by 10 inches, 10 inches by 16 inches, 16 inches by 20 inches, 20 inches by 32 inches, 32 inches by 40 inches, 40 inches by 64 inches, etc. Such a simple multiple series is easily remembered by the draftsmen, and also makes it possible to fold larger prints down to smaller sizes for purposes of transportation. If the base size were 7 inches by 9 inches, the series would be 7 inches by 9 inches, 9 inches by 14 inches, 14 inches by 18 inches, 18 inches by 28 inches, 28 inches by 36 inches, 36 inches by 56 inches, etc., and the first two of these could be filed vertically.

Most drafting rooms are accustomed to purchase their supplies of paper in rolls, and where drawings are of such widely varying sizes as to prevent their reduction to a standard series, this method of purchase may be wise. It is, however, never easy to keep either flat or vertical any papers that have ever been rolled, and for the methods of filing suggested in this article, the purchase of paper in flat sheets is strongly recommended. Many drafting rooms find it to their advantage to use such kinds of paper as may be secured from wholesale paper houses in ream lots rather than to procure their supply from firms dealing in drafting materials. Paper bought flat can be delivered cut to sizes a little larger than standard (allowing for thumbtack margin, etc.) and, if the multiple series of standards is used, the larger sizes can always be cut down to the smaller without waste. The use of small drawings permits the employment of tracing paper instead of the more expensive tracing cloth, except where tracings are to be subjected to severe wear. Blue prints that are to have hard usage in the shop should be mounted on stiff cardboard; where the mounting is of frequent occurrence it is good economy to have cardboard coated with the sensitive solution, and blue-print directly on that, thus eliminating entirely the operation of mounting.

A standard method of placing name, number, and other needed instructions on drawings is always desirable. For vertically filed drawings the following arrangement will prove convenient: the upper right-hand corner to contain plan number, upper left-hand corner the name of the drawing; both of which may be consulted in a vertical file without removal. In the lower corners may be put the scale, specifications as to material and finish, and a list of such standard screws, nuts, pins, bolts, etc., as belong with the part, if the nature of the work does not require such standard supplies to be put on a separate sheet. When drawings are to be filed flat, the lower edge is the one that can be consulted without removal, and the right and left-hand lower corners should contain respectively the plan number and name, the remaining information being in the upper corners. The time required to properly letter drawings as outlined above is a serious item in many drafting rooms, and the attempts to solve it by impressions from metal or rubber stamps or stencils have proved unsatisfactory. An efficient method is to have a form printed in opaque black ink (by a regular printing office) on standard sizes of tracing



ADJUSTABLE BLOCK

MAKE ① CAST IRON ƒ ALL OVER

PLAN NO. A-7-8
BY JSM
DATE 7/3/02

DRILL FOR 3/16" ADJUSTMENT PIN
1/2
1/2
DRILL AND COUNTER-SINK FOR 1/2" SCREW
1/4"
5/8"

FURNISH:—

QUAN.	DIAM.	THRD	LEN'TH	SHAPE	DESCRIPTION
1	1/4"	20	5/8"		FLAT HD MCH SCW
1	3/16"		2"		ADJUSTMENT PIN

WHITE & GREEN MFG. CO.
All plans must be returned
on completion of work.

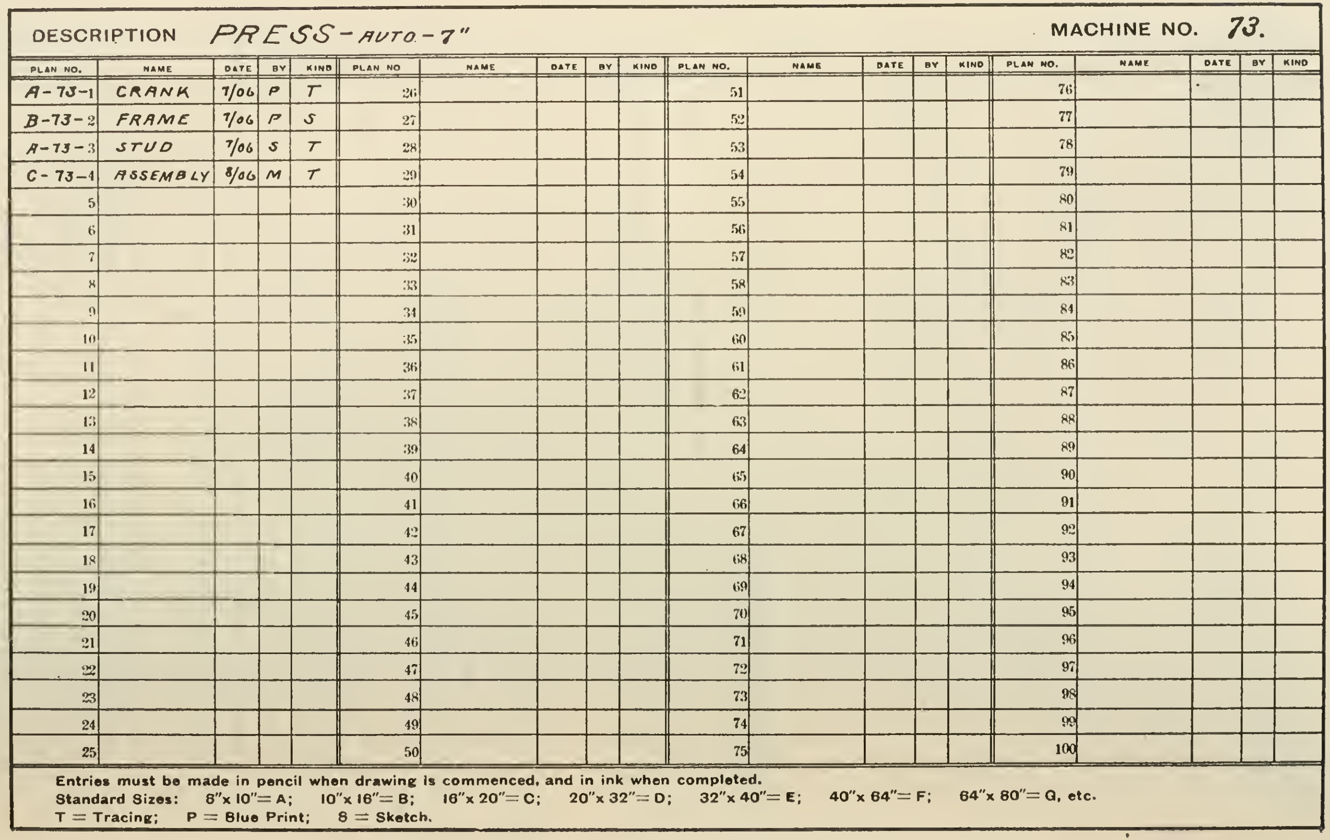
SCALE = 1

FIG. 7. SPECIMEN TRACING MADE ON PRINTED FORM, SHOWING STANDARD METHOD OF MARKING.

Reduced from 8 by 10 inches.

paper or cloth, such form to contain all words or instructions that must go on every drawing, such as "plan no.," "date," "by," "scale," firm name, ruled schedule for the list of standard supplies, and any other standing instructions that may be required. This will save considerable of the draftsman's time, give the drawing a neat and orderly appearance, and make it less easy to forget to insert any of the information for which printed spaces are provided. In smaller departments, and where the printing of such forms is not feasible, similarly lettered dummies of the various standard sizes can be carefully prepared on heavy cardboard, and thus maintain the standard locations of the various items of information, and enable them to be quickly traced.

To be efficient the system of listing or indexing drawings should be so simple that each draftsman can make proper entries of his own work in such a way that it can be easily understood by anyone who may have occasion to refer to it. Libraries have solved a corresponding question for books in the well known Dewey decimal classification system, and a similar method has been found to serve well



DESCRIPTION *PRESS-AUTO-7"* MACHINE NO. *73.*

PLAN NO.	NAME	DATE	BY	KIND	PLAN NO	NAME	DATE	BY	KIND	PLAN NO.	NAME	DATE	BY	KIND	PLAN NO.	NAME	DATE	BY	KIND
A-73-1	CRANK	7/06	P	T	26					51					76				
B-73-2	FRAME	7/06	P	S	27					52					77				
A-73-3	STUD	7/06	S	T	28					53					78				
C-73-4	ASSEMBLY	8/06	M	T	29					54					79				
5					30					55					80				
6					31					56					81				
7					32					57					82				
8					33					58					83				
9					34					59					84				
10					35					60					85				
11					36					61					86				
12					37					62					87				
13					38					63					88				
14					39					64					89				
15					40					65					90				
16					41					66					91				
17					42					67					92				
18					43					68					93				
19					44					69					94				
20					45					70					95				
21					46					71					96				
22					47					72					97				
23					48					73					98				
24					49					74					99				
25					50					75					100				

Entries must be made in pencil when drawing is commenced, and in ink when completed.
Standard Sizes: 8"x 10" = A; 10"x 16" = B; 16"x 20" = C; 20"x 32" = D; 32"x 40" = E; 40"x 64" = F; 64"x 80" = G, etc.
T = Tracing; P = Blue Print; S = Sketch.

FIG. 8. CARD-INDEX RECORD OF PLANS. REDUCED FROM 5 BY 8 INCHES.

for drawings in the drafting room. Take for instance: "Plan No. B—41—65" and analyze the three component parts of this number. "65" indicates that the drawing in question was the sixty-fifth on this particular machine or piece of work on hand, and this much of the plan number is assigned as soon as the pencil sketch is started. "41" serves as the distinguishing number of the machine in process of design, or a certain section of it, if it consists of many drawings. It may represent equally well the group number of any other kind of drawing. The letter "B" refers to the size of the drawing in question, and shows in what size filing compartment it may be found. Previous to this a series of standard sizes should have been determined and each size given a letter designation as: A, 8 inches by 10 inches; B, 10 inches by 16 inches, etc. If necessary, more than three component parts of a number may be used.

A complete list should be kept of the different plans on each machine or group, and the form on page 376 will be found serviceable. It should be printed on either 5-inch by 8-inch index cards or loose-leaf-ledger sheets. The foot notes sufficiently explain its use. It is sometimes convenient to keep these lists on printed cards 8 inches by 10 inches and file in the vertical file with the drawings. In large drafting rooms an alphabetical, or otherwise classified, cross index of machine or group numbers is necessary.

The employment of mechanical devices for computation and measurement is to be encouraged wherever accuracy and economy are conserved or increased. The use of the so-called drafting machines is not to be recommended, as they are usually cumbersome, and either too stiff for convenient handling, or too loose to be accurate. Where cross-hatching is to be done in considerable volume, some of the simpler forms of parallel-ruling devices will be of value. But the use of all mechanical aids depends so much upon the nature of the work as to place the responsibility, and properly, upon those immediately in touch with the situation.

The economical use of valuable time should receive careful attention in a drafting room, but the limits of this article will permit only the general statement of the fundamental principle: each and every employee should be given work that will draw out the best of his ability. E. g., it is rarely advisable to assign the routine work of tracing details and lettering to one who is able to do more important work, as such a procedure is at once discouraging to the man, dwarfing his abilities and ambitions, and at the same time not economical from the standpoint of the employer, as it introduces a disproportionate ratio between the cost of labor and the value of the work.

THE HEAVY MOTOR VEHICLE INDUSTRIALLY CONSIDERED.

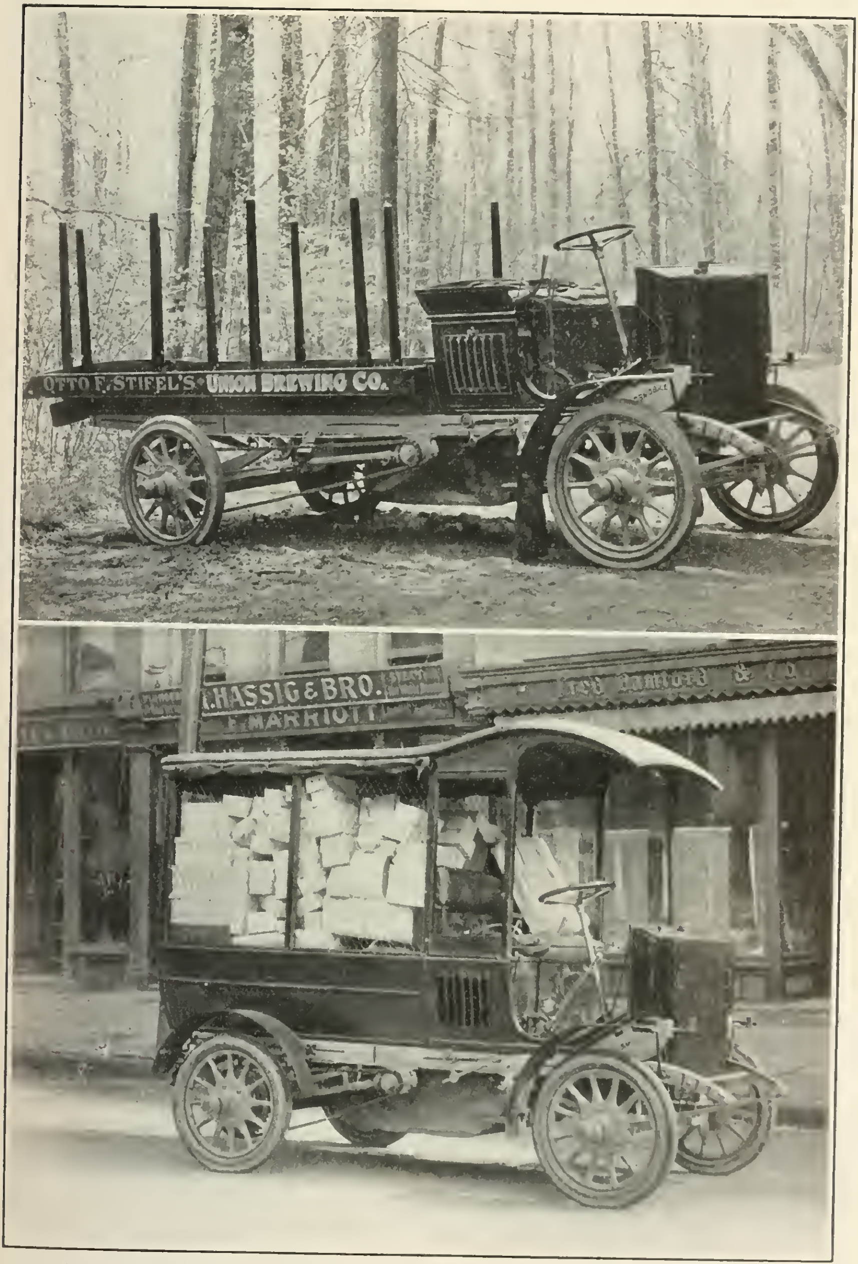
By John McGeorge.

Mr. McGeorge approaches his topic from the American point of view, thereby supplementing and completing the survey formerly made of the subject in these pages by F. M. Maynard, who reviewed British motor vehicles, and more recently by L. Perissé, who in our issue for March, 1905, summarized the state of the art in France up to that time.—THE EDITORS.

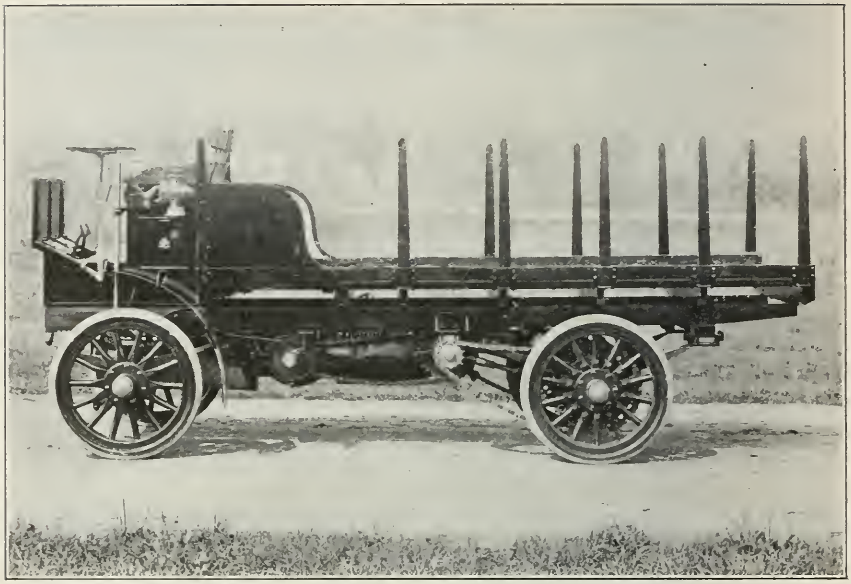
CONSIDERING this subject from the American point of view, we naturally look first at the general conditions under which the vehicles are to operate. Our attention is at once attracted by the inadequate facilities for transport between the city and country for comparatively short hauls, say from 10 to 30 miles into the country, or from large cities to nearby small towns. For instance, a store in a city sells a bill of goods(say household furniture) to a customer 20-miles out; this is too far for delivery by wagons, as it would necessitate a two-days trip, and by rail would cost too much in terminal charges and transferring from dray to railroad car and back to dray; but by motor wagon the whole trip can be made in one day, without any transferance.

The delivery companies which try to deliver from city to country are few and small and can seldom afford more than one or two-horse wagons for this purpose. Hence the need for better service, and this points in the direction of the heavy motor vehicle. There is also involved the question of road surface, type of vehicle, tires, administration, etc., all of which will be considered hereafter.

Considering the particular conditions under which to operate, we first turn to the service. For dry-goods and similar houses, we seem to require light, fast-running vehicles, with a carrying capacity from 1,000 pounds to 2,000 pounds; for the city delivery of light parcels, this field is being filled very acceptably by a number of firms, such as the "Oldsmobile" and others, which have adapted the chasses of their pleasure cars to this purpose. Houses of this character also run heavier vehicles of the same type up to 4,500 pounds, and also, in common with other merchants, require open trucks, such as are made by the Maxwell Company, the Knox, and others, both of the open and closed types.



TWO EXAMPLES OF THE OLDSMOBILE—A HEAVY TRUCK AND A LIGHT DELIVERY WAGON FOR CITY SERVICE.



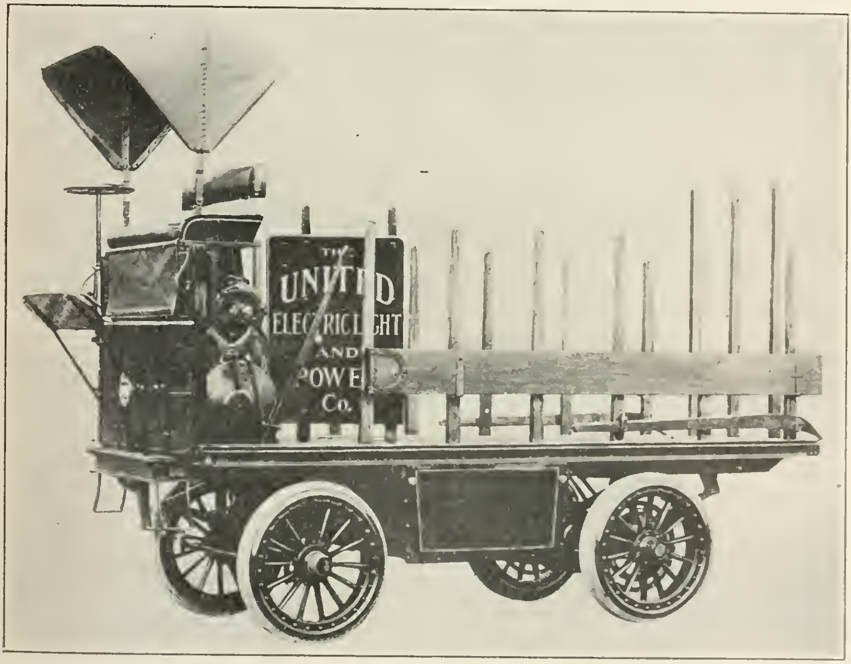
KNOX WATERLESS 3-TON TRUCK, REMOVABLE STAKE BODY.

Wheel base 111 by 60 in.; wheels 36-in. diameter; tires 4-in. front and 5-in. rear; body 12 by 5½ ft. inside; weight, 4,800 lbs.; engine, 2-cylinder, 5 by 7, air cooled. Knox Automobile Co., Springfield, Mass.

Hardware and similar houses require principally the heavier type of vehicles, and these firms are so mixed with the supply houses that not only the types shown are used, but also a heavier open type, such as the 5,000-pound to 6,000-pound Knox. Warehouses and express companies call for open lurries, with flat tops or stake sides, of the type shown by the Holson Company, and the Packard Company, of all capacities from 2,000 to 10,000 pounds. Structural-iron workers call for lurries with perfectly flat tops, with the exception of the driver's seat, of capacities from 1,000 to 10,000 pounds and over, of types which have not yet been seen in America, but which are growing common in Europe.

The next point in the consideration of conditions is that of administration; by this we mean principally the personnel of the men in charge of the installation. Large stores with their own stables, etc., usually put a competent man in charge who knows how to keep his horses and plant generally in good order, and also does not hesitate to tell the general manager just how much his department can do. Similarly we require a man in charge of an auto delivery plant, whether it be one vehicle or a hundred, who knows what should be done to keep his vehicles always in order, and *who will do it.* The superintendent of the delivery service also should study the powers of the motor wagon, as to speed, length of routes, frequence of stops, etc., in order to suit his service; in the horse delivery service, this suiting of service has gradually grown up and crystallized into a set route at set times, but the motor wagon is often put in as a complete installation, and requires the whole system to be devised at once; and as the motor wagon will make from 30 to 50 miles per day, or more than two trips to the horse-wagon's one, this will call for more careful adjustment of hours for preparing and loading shipments, and will keep the packers and shippers more steadily at work.

The economy of auto delivery is now at such a point that the balance is on the side of the auto vehicle; but given two exactly similar plants, one man will show a good margin of profit on the side of the auto, whilst another man will show a big margin on the other side. Montgomery, Ward & Company say: "The maintenance means a great deal, and unless it is carefully looked after by one who thoroughly understands it, the trucks will lose money very quickly."



FIVE-TON ELECTRIC TRUCK. RADIUS OF 25 MILES ON ONE CHARGE.
Note electric and hand-power winches and skids for loading. Built especially for cable reels, etc. Speed 6 miles per hour. Vehicle Equipment Co.

This does not necessarily mean that an expensive man shall be put in charge, but that a man should be picked out who will love his machines, just as a good man will love his horses.

Next we have in the conditions to be considered the question of road surface and foundation. We have to confess to all kinds of roads in the United States. Our dirt roads (?) are simply a heap of soil scraped up into a ridge by the farmer's scrapers; these wear into ruts with a big ridge between, and this is often forgotten in allowing for the road clearance. These roads are also soft, needing broad tires; this also is frequently forgotten or wilfully ignored. They also wear in holes, and these holes fill with water which splashes up and carries mud and dirt into unprotected parts. Macadam or telford roads are liable to all the foregoing faults, but in a much less degree, depending upon the quality of the foundation, but with the further fault that when there is a hole, the wheels drop in with a greater shock. Asphalt roads have all the faults of macadam roads, of course in a still less degree, with the added fault of slipping and skidding in bad weather. Stone pavements have the fault of jarring the machinery, and so have wood pavements in a lesser degree. This looks like a formidable indictment of the roads, but we are at present looking for faults in order to provide remedies on the vehicles. All these conditions affect the questions of tires, power required, ease of steering, whether the load should be hauled or pushed (front or rear drive), or carried or driven by all four wheels.

Another condition which must be considered is that of the width of streets in some cities and the closeness of the space for manœuvering. Again, we have the question of grade to look at. At Tarrytown, N. Y., grades generally may run up to 16 per cent; at Cleveland, O., we have grades up to 12 per cent, and at Cincinnati, O., about similar grades, so that we should provide power in most places for at least 20-per-cent grades on the slowest speeds, in order to allow for bad spots and holes.

Having looked at the general conditions of the road service, etc., we are now ready to look at the types of machines. First, steam comes naturally to our thoughts; steam has had a great run especially for heavy loads on account of its flexibility. If the engine is made large enough to pull the vehicle out of any hole it may get into, then the speed can be adjusted to any point by means of the throttle, and this has been the strong point in favor of the steam engine. A steam engine will run and get home even if badly out of repair, and it seldom happens that a boiler gives out all at once. Against these points,

A LIGHT DELIVERY WAGON OF 30-MILES RADIUS AND 10-MILES SPEED. CARRYING CAPACITY 1,000–1,500 LBS.

The Vehicle Equipment Co., N. Y.

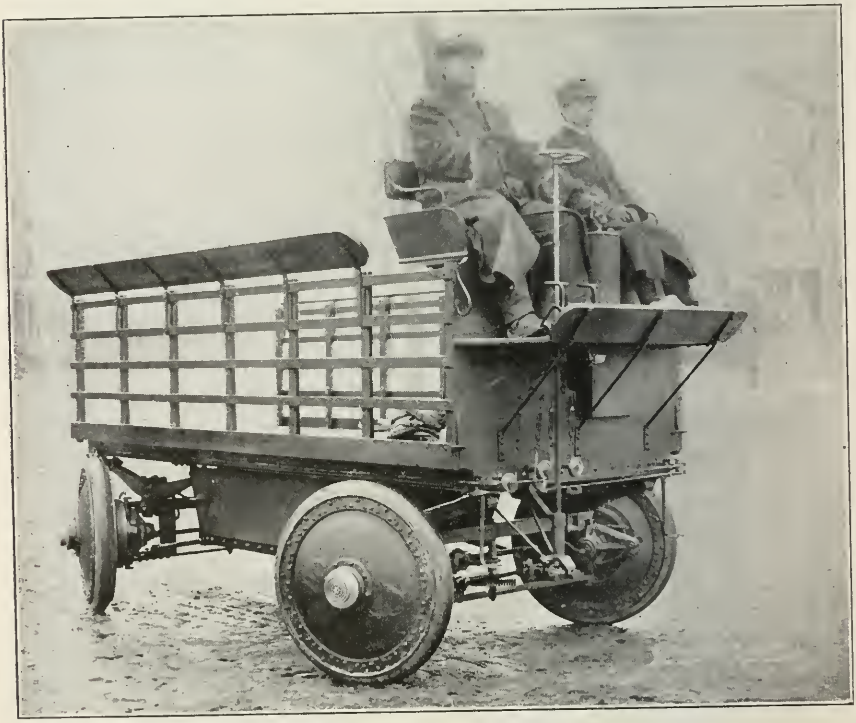
is the fact that a steam engine takes more fuel in the shape of gasoline than an internally fired engine, and that the machinery is heavier than a gasoline engine, thus reducing the load efficiency in proportion to total weight.

A flash or semi-flash boiler will keep in good repair for a long time, but the burner and its regulator need close watching, and the water regulator must also be closely adjusted. A tubular boiler soon gives trouble, by burning out tubes, and even the most expert chauffeur gets caught occasionally. A condenser must be carried or water must be taken at frequent intervals. In all this I have only considered a liquid-fuel furnace, as I believe that none would seriously think of a coal or coke-fired boiler.

The transmission of a steam engine is simple, as we only have enough gearing to allow the engine to run at a fair speed in order to keep down the size of the cylinders.

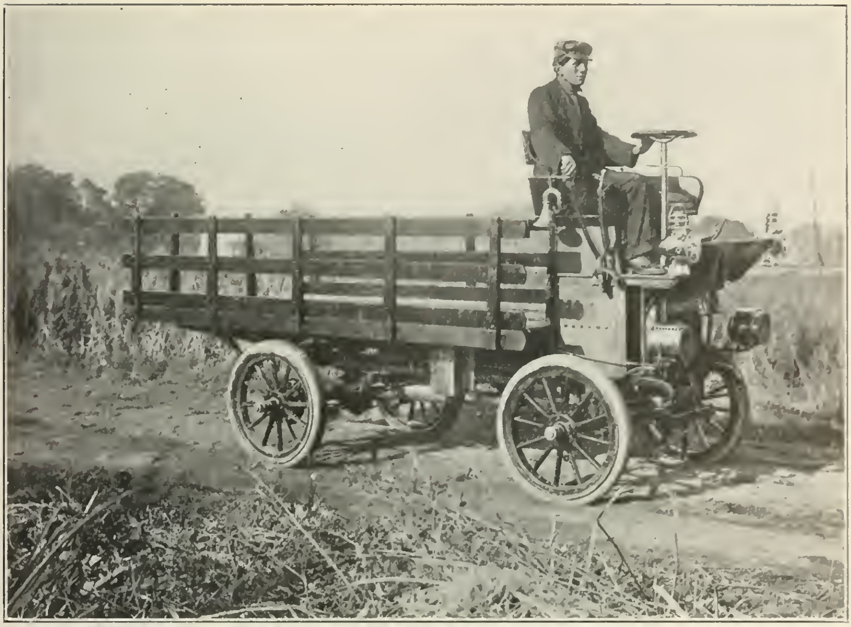
In electric vehicles we have an ideal transmission of power, in that we can obtain a large range of speeds with little loss of efficiency. We also have a very simple mechanism with regard to motor and transmission. We have an ideal vehicle in regard to quietness and cleanliness, but here the advantages end. The batteries need great care; they are costly and deteriorate quickly, and are heavy. The cost of operation per road mile is great, amounting to 1 cent per ton mile of freight in the very best case we have record of; and in this case the load being 4 tons, the vehicle also weighed 4 tons, which equals ½ cent per ton mile of total load. This cost is for fuel only (current).

Gasoline engines have rapidly come to the front in late years and are now very reliable machines. The advantages are low fuel cost, light weight of machinery, and considerable flexibility of control. The disadvantages are increased cost and complication in the transmission gearing, the use of electric spark with its consequent batteries or magneto, and the carrying of gasoline (and water in the case of water-cooled cylinders) and the demand for a somewhat more experienced driver of the vehicle. The control is not as flexible as that of steam, but more flexible than electric.



ELECTRIC TRUCK WITH MOTORS IN THE WHEELS.

Four-tons capacity, steering on four or two wheels; or, front and rear wheels can be set parallel to travel obliquely. Holson Motor Patents Co.

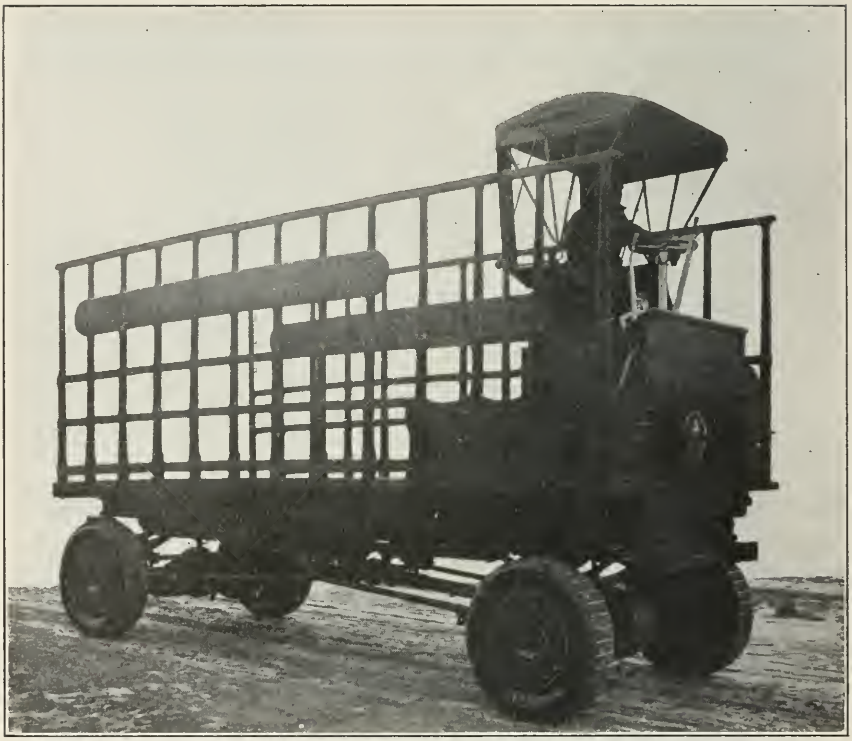


A MAXWELL TRUCK MAKING AN AVERAGE OF 17½ MILES A DAY WITH 2,200-POUNDS LOAD.

9½ miles per gallon of gasoline, maximum grade 16 per cent; two cylinders, 5 by 5; wheels, 32-in. diameter; tires, 3½-in. front and 4-in. rear; platform, 10½ by 6 ft.; weight, 2,600 lb.

Crude-oil engines have not yet been proved to be sufficiently successful to warrant their general employment, although we have records of gasoline, heavy oil, pure alcohol, and carbureted alcohol being used in the same engine without alteration, with good results.

Combination power plants have come rapidly to the front, notably in the gasoline and electric combination, the most successful of which has been a gasoline engine driving an electric generator with a storage battery to take the surplus, the power being applied by means of electric motors to the axles. A large railroad car built on this system is now running over the various roads of the United States, with remarkable success as to smoothness of running, cost of fuel, and cost of repairs. Whilst speaking of railroad cars I may say that a car is now having its machinery put in it at Akron by the Wellman-Seaver-Morgan Company, with gasoline engines geared to the axles. This engine has eight cylinders, 8-inch diameter by 8-inch stroke, and is estimated to give 200 horse power at a speed of about 750 revolutions. There are three speeds, each operated by a separate clutch. The cars are 45 feet long over all, and seat 44 passengers. It is intended to



SEVEN-TON GASOLINE TRUCK, EACH WHEEL INDEPENDENTLY DRIVEN, STEERED AND BRAKED.

Wheels, wood-tread, 8-in. wide; engine four-cylinder, 6 by 6, water-cooled; drives through bevel gears; speed 15 miles; body 18 by 7 ft.; a windlass can be operated by the engine, independently of the wheels, for loading or for getting out of a hole.
The Four-Wheel Drive Co., Milwaukee, Wis.

make an average of about 35 miles per hour, with a maximum speed of 60. The control is by throttle in addition to the changes of gearing. The electric lights for the car are supplied from a storage battery which also gives power for the air compressor, the brakes, and to start the main engine. This car is being built for use on the L. S. & M. S. R. R., under Mr. Chase's patents.

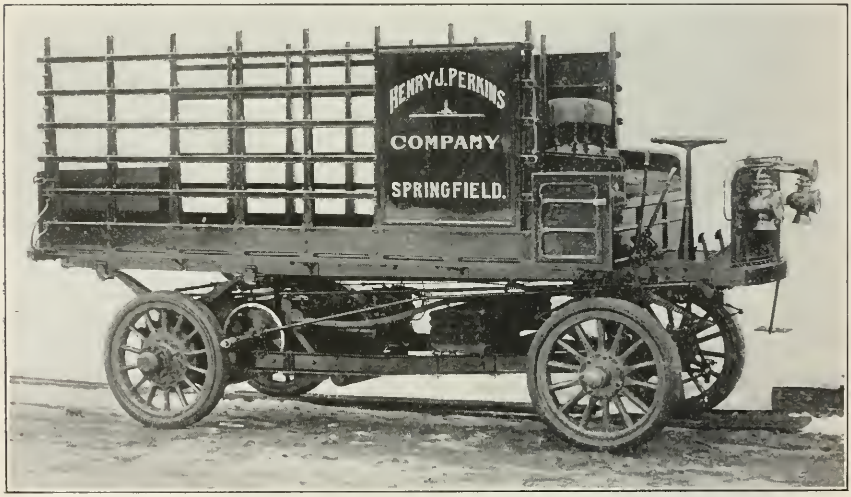
The third of the conditions is one closely related to the question of roads, viz., tires. For commercial work we have on the market, first, solid-rubber tires, many of which have been very successful, but we have to face the fact that rubber is becoming more scarce and expensive every day. Some firms are turning to wood blocks in the tires, as in the truck made by the Four Wheel Drive Wagon Company, of Milwaukee, Wis., who are using these blocks, with the end grain turned to the roadway, and with good sucess. It is still a question if we will not be able to return to the use of steel tires of sufficient width not to injure the roadway. It is possible that some modification of the various spring tires which have been suggested may be found to give the necessary grip, without cross bars. Pneumatic tires can be used only up to comparatively light weights and are practically out of consideration for commercial work.

Having gone over the conditions under which we are to operate, let us look at some of the machinery.

In the steam machines, among the most practical seem to be the White cars, with their semi-flash boilers. In these boilers, the water is pumped in proportion to the speed of the engine, with the result that when the engine is laboring, in consequence of a heavy road or grade, and is running slow, the pump is also running slow and failing to give steam to the engine. This has been partly remedied on the "1906" cars by giving a change of gearing for the heavy work, so that the great advantage that steam had in its flexibility of control, as compared with gasoline, really disappears when this point is considered, together with the smaller efficiency of the fuel in its conversion to power through the medium of the furnace boiler and engine, its less weight efficiency (that is greater proportion of dead weight to paying load) it would appear that the field for steam vehicles is rapidly diminishing. The strong point influencing the selection of steam for any given service is that almost any mechanic can repair and adjust a steam engine and its attendant machinery.

Electric vehicles have a field which seems to be peculiarly their own in the light delivery service, from dry-goods houses and similar work, especially when the service is sufficiently large to warrant the establishment of a good sized garage with an efficient superintendent; but these vehicles should not be used when the grades are heavy, as the storage battery is best suited for a steady delivery of power at a comparatively low rate. The expense of running these vehicles amounts to approximately 2 cents per ton mile for current. The brewery-wagon field seems to have been practically pre-empted by the electric vehicle, but why I cannot see, except that where a garage is maintained with an efficient staff, a cheaper class of driver can be used; but we find that some of the large companies are now trying gasoline vehicles for this service, with good results. The expense of tires is greater than either steam or gasoline as the dead load is greater, and the upkeep of the batteries is another heavy item.

The gasoline vehicle has been so much improved in all its details that it would seem to fill the bill for all classes of work. The engine has been improved in its flexibility by the addition of more cylinders (although this is against it on the score of multiplication of parts) and the recent advances in air cooling would seem to indicate that it is possible to dispense with the water tank. It is necessary to have a little higher grade of intelligence on the part of the driver to detect and remedy any faults which may show up in the carburetor or the spark connections (which, by the way, are invariably the result of careless work in the fitting of the wires and connections), and the various adjustments required. Here again the necessity of a good man in charge of the installation shows up, as the difference in management will make all the difference between success and non-success.



A THREE-TON TRUCK WITH BODY FOR WHOLESALE GROCER'S SERVICE.

Note underframe with engine geared by spurs to axle; two cylinders, 6 by 7; wheel base 9½ ft. by 58 in ; wheels 36-in. diameter; tires, front 5-in., rear 6-in.; weight, 6,000 lb., speed, 10 miles. Knox Motor Truck Co.

Taking the question of economy, we do not find that much has been published showing the cost of operating either steam or electric vehicles.

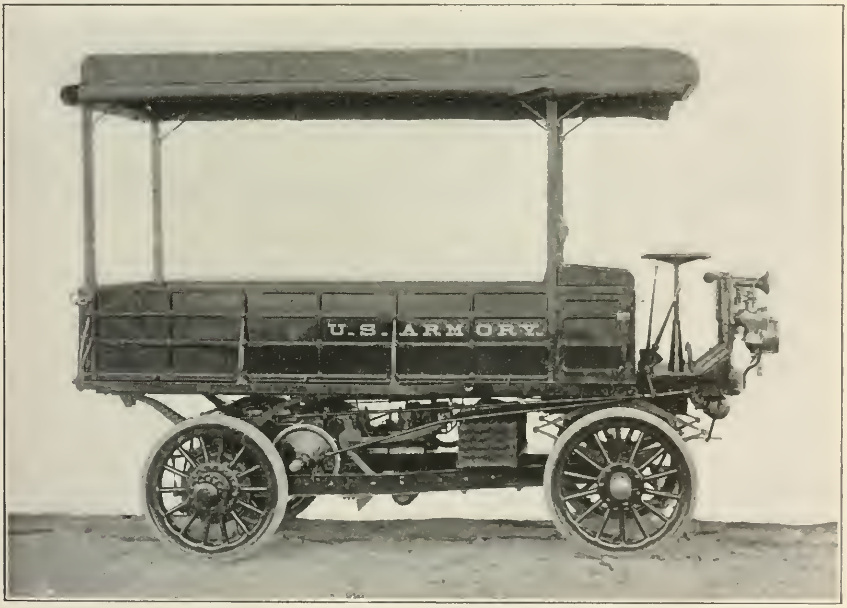
A Thornycroft steam wagon has run at a cost of 7 cents per ton mile in 1902, including all costs.

A Leyland wagon was tested against horse power under the same circumstances, and showed a cost of 12.5 cents per ton mile against a cost of 20 cents for horse wagon; this was in 1899.

In 1898, a three-ton Thornycroft wagon carried its load at a cost of 0.7 of a cent for fuel per ton mile.

A three-ton Leyland wagon carried its load at a cost of 1.1 cent for fuel per ton mile. It is not probable that the cost of running has been reduced since that time, and it is more than probable that the American vehicles can run about the same in cost of operation.

The Holson electric truck, which drives all four wheels with a separate motor in each wheel, claims an economy of 200 watts per ton mile, which at 5 cents per kilowatt would equal a cost of 1 cent per ton mile for current. An ordinary electric vehicle will probably cost at least 2 cents per ton mile for heavy vehicles and much more for the lighter cars. The cost of batteries must also be charged to the fuel account, and it is impossible to say just what this will be as here, particularly, the personal element of the superintendent comes in.



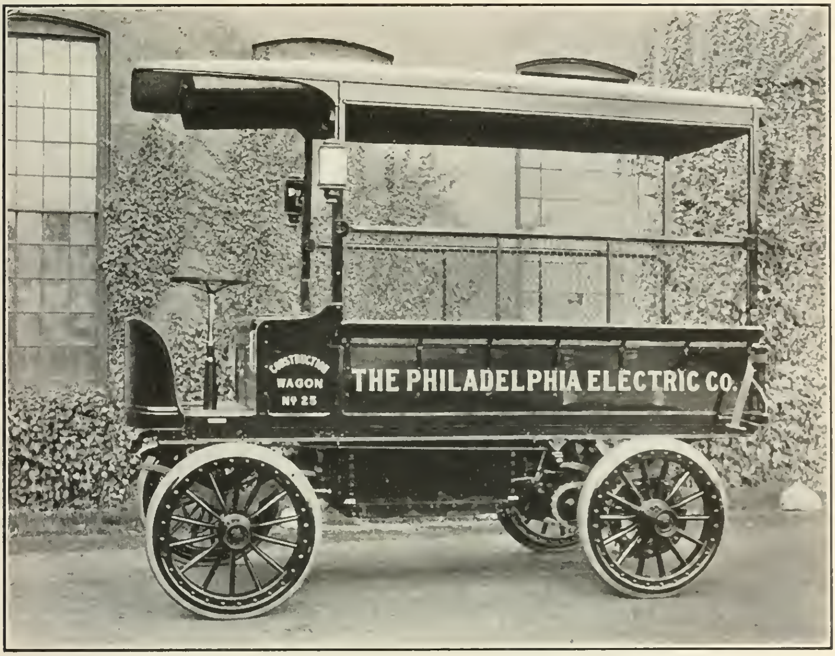
A TWO-TON TRUCK WITH EXPRESS BODY AND TOP.

Engine, two-cylinder, 6 by 7; wheel base, 8 ft. by 5 ft. 8 in.; wheels, 36-in., tires, front 4-in., rear 5-in.; weight, 4,000 lb.; speed, 12 miles. Knox Motor-Truck Co.

Repairs are also a very indefinite quantity. One firm in Cleveland, Ohio, gave up a delivery wagon on account of the cost of repairs, which in my opinion was solely on account of the incompetence both of the man in charge and the repair man. Gasoline vehicles have the cleanest records of all, I have before me a record of a Knox, gross weight approximating 2 tons, in the Glidden Tour, including all stops, etc., in a 1,000-mile run, at a cost of $23.50; this equals 2.35 cents per mile for gasoline and lubricating oil. The load carried varied from 1,500 to 2,500 pounds, and a great deal of hill work was done. The gasoline cast 20 cents; in Cleveland we pay 11 cents; this would bring the cost down to 1.4 cents per mile. The Packard Company, on the same tour, with a net load of 1,500 to 3,200 pounds, consumed 39 gallons of gasoline at 11 cents (the price in this city) =$9.79, plus 4 gallons lubricating oil =$2.00; total $11.79, or 1.17 cents per mile. These are not exceptional records, but taken from the first we have at hand.

The question of repairs is again a very variable one, but with well made cars of the quality of material now being used by the best makers, and a good man in charge, they should be a very small item. Amongst the conditions that are common to all the classes of vehicles, is the question of road clearance. As mentioned in the beginning of this article, it is essential that the vehicles be suitable for traveling over poor roads full of ruts and holes. I note that in London, with its good roads, the minimum clearance specified by the authorities for motor 'buses is 10 inches, and I think that for American roads this should be at least 12 inches; this would call for somewhat larger wheels than American makers have been using, but this would be a good thing all around.

The width of tires has also been touched upon, and here it is to be feared that Americans are not wise. On horse vehicles we have used narrow-tired buggy wheels, because for the one particular trip we run lighter, forgetting that the light running is at the cost of cutting up the road and making it so much the worse for the man following us. This tendency also obtains in our motor vehicles. If we used broader tires we would soon find that the results would pay in the improved condition of the roads, and this, of course, would react on the power required. We should therefore insist that one of the most vital conditions of success with any type of commercial vehicle is that the tires shall be broad enough to carry the weight without cutting the roads. If manufacturers could get together and determine the width of tire for a given load, making this load suitable for soft-dirt roads, we would effect a long step forward. The material of the tires affects the mechanism. We have an instance of a back axle with roller bearings which was standing its work perfectly with pneumatic tires, but a customer wanted solid tires and in one week's run the axle was reduced 1-16-inch in diameter, so that in this case the axle should be harder to stand the impact



AN ELECTRIC VEHICLE OF INTERESTING TYPE.

from the road surface through the solid tire. Under the speeds called for by commercial vehicles, it would appear that solid tires can be used, either of wood or rubber, and in the case of the heavier, slower vehicles, even steel tires could be used. It is understood that this would call for pinning or otherwise securing all nuts and fastenings, and making all parts both hard and tough; but with the quality of material now being used on this work, this result can be obtained. One essential condition of success is that the transmission of the power from the motor to the wheels shall be as simple and direct as possible.

The question of speeds in the gasoline car is best solved by change gearing, but if this gearing is made of substantial construction, this should never be heard from so long as the car will stand up. The question of compensation between the two sides of the vehicle has been accepted as being solved by the differential, but there is a serious question mark against this. When one wheel of a differential axle strikes a soft spot, the power will simply spin it around, using the other wheel as a fulcrum. Again, with a back-wheel-driven machine, if one driven wheel strikes an obstruction with the other driven wheel on firm ground, and the forward wheels are at the same time on slippery ground, the result is a skid, and the vehicle will turn back-end first. Now, if the wheels were driven through ratchets (as is practically done in the Hedgeland patent) the result would be that the wheel against the obstruction is the one that would have the power applied, and in the case of a soft spot, it would be the wheel on the firm ground that would have the power applied to it. Here is food for thought, for in my opinion the differential is not the best solution. The "Holson" and the Four Wheel Drive Company solve this by putting power separately into all four wheels.

Again the question arises, which wheels should do the driving, the front or the back wheels? I think all are agreed that the front steer is the best, and it would appear to be easier and more efficient to pull the load than to push it. This would imply that the power and the steering should be applied through the front wheels, and that (better still) all four wheels should be driven; the motion then becomes one of translation only and eases all the strains of driving from the body of the truck. Whilst on the subject it would appear that for bad-road work for heavy trucks, we should take a leaf out of the English traction-engine books and use a small windlass on the trucks which can be used to pull out of a bad hole; this windlass can also be used for loading the trucks.

KNOX WATERLESS 2,500-POUND TRUCK, STAKE BODY WITH PLANK SIDES.

Note the chain grips on the drivers.

Considering the purpose of this article, which was to try to determine where each type of machine should be used, it would appear that the field of the steam engine is rapidly narrowing, as its one great advantage—that of its flexibility of control—is being caught up

A 7,000-POUND LOAD OF COKE ON AN "ATLAS" TRUCK.

Two-cylinder engine, 6 by 7; wheel base, 9 ft. 6 in.; tread, 58 in.; wheel diameter, 36 in.; tires, rear 6 in., front 5 in.; weight. 6,000 lb.; speed, 10 miles an hour.

with by the gasoline motor. Its next advantage, that of increasing pressure for hill work, is more than discounted by the ease of changing gears of the gasoline, and we have seen that both steam and electric have had to copy the gasoline in this particular. But where established mechanics, who are not familiar with electric and gas engines, have to take charge, then the steam has its field.

The electric power seems to have its advantage for short hauls, for goods that would be affected by gas fumes or damp, or where quietness is an essential, or where a natural source of power (such as a waterfall) is available. But nearly all the advantages inuring to the steam and electric systems for commercial work are closely approached by the gasoline, or internally fired engine. By the multiplication of cylinders and the improvements in the carburetors and throttle and other systems of control, we are now making the control of the speed in these engines very flexible. By good systems of transmission, especially by sliding gears, in view of the excellent quality of material now being used, and other systems which are now under experiment, a power of climbing hills and getting out of holes is possessed by the gasoline engine which surpasses either steam or electric. The one drawback is the apparent complication of the engine, and the want of knowledge of the gasoline engine, especially of the electrical parts necessary, both on the part of the manufacturers and users of this machinery. I say manufacturers advisedly, for repeated instances have come to my notice, of either careless or ignorant wiring, and even in induction coils I have seen careless workmanship which gave considerable trouble before the cause (which was slight and easily remedied) was found out. But this fault should be overcome by the employment of competent men in the case of large installations, and in the case of one or two wagons the owner himself must be familiar with his plant.

With respect to fuel economy, the internally fired engine is preeminent, as shown not only by demonstration, but by figures from months of running which have been published by both manufacturers and users. And in the economy of repairs, the internally fired motor is coming to the front, as manufacturers are realizing the conditions and providing for them.

Tires I have not gone into closely as these are common to all types. Suffice it to say that as improvements are made in the machinery and springs, the problem of tires will become easier, and harder tires can be used.

Regarding costs, etc., I give some general figures, which, of course, vary considerably, but which go to substantiate all that has been said.

The Moxie Nerve Food Company, of Boston, have run fourteen autos of a light class for two years, and in 1904 the repair bill for 8,000 miles (not including tires) was a little over $5.00. A clothing store at Albany, running a car of the light "Oldsmobile" type says that the car covers about 50 miles per day, equaling the work of two horses and costing considerably less than the keep of two horses.

The Troy Laundry Company of Los Angeles cover about 35 miles per day with each of two small electric cars. Another firm in the same city have covered 50 miles a day with an electric car, and are about to put in six gasoline cars.

Montgomery, Ward & Company are running 5-ton trucks, and wear out a set of tires (7 by 86 inches) in a year, costing $640.00; batteries cost from $600 to $900, and also last one year in hard service. This firm say that motor wagons are undoubtedly cheaper and more efficient in every way than horse wagons and they are doing all their trucking by motor wagon.

The Anheuser-Busch Brewery Company have over thirty electric trucks in St. Louis, and more in other cities and are building more; they are trying out gasoline cars.

Lyon & Healy have gasoline trucks and give the following figures for maintenance and operating:

Gasoline Truck		*Horse Truck*	
Gasoline	$30.00	Horses	$120.00
Oil	6.00	Repairs Washing Harness	40.00
Batteries	3.00		
Repairs	2.00		
Driver	180 00	Driver	180.00
	$221.00		$340.00

They also state that one gasoline truck will do the work of two horse trucks. A. H. Revell & Company also state that one motor truck will do the work of two horse trucks, and give the following figures:

Electric Truck		*Horse Truck*	
Driver	$64.00	Driver	$64.00
Charging	30.00	Horse feed	40.00
Washing Repairs	10.00	Repairs Harness Washing	10.00
	$114.00		$114.00
			2
	$114.00		$228.00

H. Bosch Company, Chicago, give the following figures for a light wagon:

Feed for one year	$120.00	Driver for 1 year	$780.00
Driver " " "	624 00	Interest (on 2500)	125.00
Repairs	25.00	Supplies: Gasoline, oil, etc.)	200.00
Shoes for team	35.00	Depreciation	250.00
Interest for one year	30.00	Tires (new set)	132.00
Depreciation (on $350)	130.00	Other repairs	25.00
	$964.00		$1512.00
	2		
	$1928.00		$1512.00

The Frank Parmelee Transfer Company give figures for a gasoline truck for a month in hard service:

Total miles traveled	1,546.5
Averaged speed miles per hour	9.72
Amount gasoline consumed—gallons	179.58
Amount oil consumed—pints	16.875
Number of stops made	2,023.
Average miles per gallon of gasoline	8.45
Average weight of daily loads	6,733.
Average number of stops per day	67.50
Total elapsed time ... hours	342.5
Time occupied in stops "	185.
Net running time .... "	159.
Total cost of gasoline and oil—$	19.33
Daily cost of gasoline and oil—cts	64.1

The Packard Company give the following figures from two companies:

	National White Lead Co. 5 days trial	Standard Oil Co. 3 days trial
No. of trips	13	10
Total miles	190.99	73.75
Average miles per trip	14.69	7.38
Total time	hrs. 28 48 min.	hrs. 11 45 min.
Total running time	hrs. 17 12 min.	hrs. 9 55 min.
Total time for stops	hrs. 11 36 min.	hrs. 1 50 min.
Average miles per hr.	11.1	7.5

The service conditions and economy of performance in the cases of the Packard cars, employed by the two companies whose figures were last cited, are further tabulated as follows:

	National White Lead Co.	Standard Oil Co.
Character of load—	White lead & paint,	Oil in bbls.
Maximum load	4,600 lb.	4,657 lb.
Minimum load	1,600 lb.	400 lb.
Average load	3,999 lb.	3,707 lb.
Gasoline used	22.5 gals.	7.25 gals.
Lubricating oil	2. pints	.333 pts.
Per gal. gasoline	8.49 miles	10.17 miles
Gasoline per mile	.94 pints	.77 pints
Gasoline per ton mile	.48 "	.40 "
Cost of gasoline and oil	$2.38	$0.81
Gasoline & oil per ton mile	$0.0062	$0.0055

Some of the figures given have come directly from the manufacturers and owners; others have been taken from the technical journals; and many others could be given, but enough has been said to show that the pioneer time for motor wagons is over, and it is now only a question of careful engineering, as in any other machine, to make a paying investment of motor wagons.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

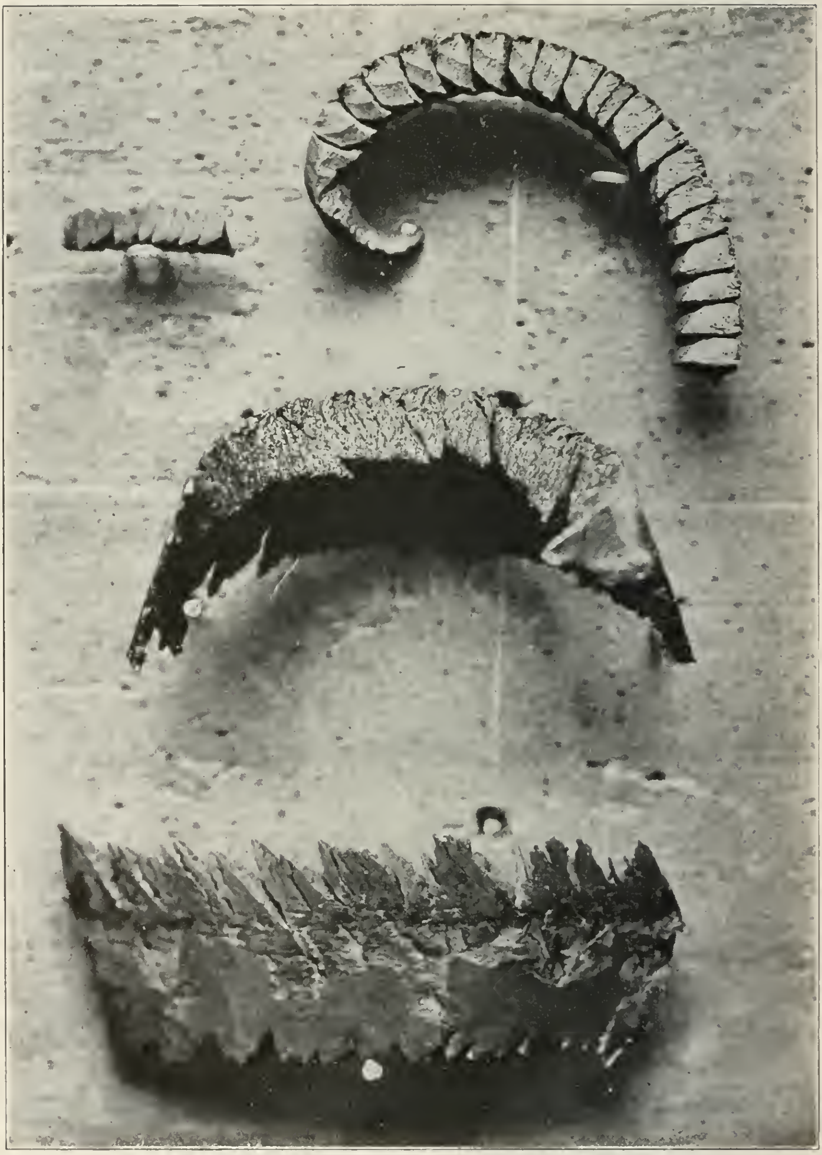
VI. THE TOOL AT WORK.

Mr. Becker's discussion of this subject began in The Engineering Magazine for September, 1905, and extended in that series to a group of four articles, taking up successively the general outline of the problem, controlling principles in introducing the steel into the shop, working directions for the making of the tools, and the design and operation of tools and machines. In this supplementary series he began last month with a discussion of the range of adaptability of alloy-steel tools, and the concluding article will present valuable data of "Feeds and Speeds with the New Tool Steels."—THE EDITORS.

ORDINARILY the thing considered most important, in bringing together a tool and a piece of work, is the mutual adaptation of tool and machine to the work to be done. Another consideration, fully as important, and in many cases more so, is the relation of the tool to the piece to be tooled—the proper bringing together of the work and that which does the work. The form or type of the machine by which this relation is established of course is determined largely by the form of the tool and the nature of the work. Thus, for instance, a rotating tool cutting at its periphery will be used in some one of the several types of milling machines; and in case it is convenient to rotate the piece to be machined, some form of lathe is indicated.

To secure the performance of the work in the most expeditious and convenient manner is the primary end, apparently, of modern machine design. To satisfy these ends the tendency has been to multiply movements and adjustments in the tool-holding and applying mechanism, with a result frequently undesirable, to say the least. The necessity for the greatest practicable rigidity in machine and tool is pretty generally recognized, and it needs no argument to show the advantage of applying the tool to the work with as few intervening parts and at as short a distance from the frame or bed of the machine as may be. Fortunately, in the manufacturing shop at any rate, the use of jigs and rigs makes any great variety of adjustments not only unnecessary, but undesirable; and it is therefore possible to attach the tool to the frame of the machine with little intermediation of parts.

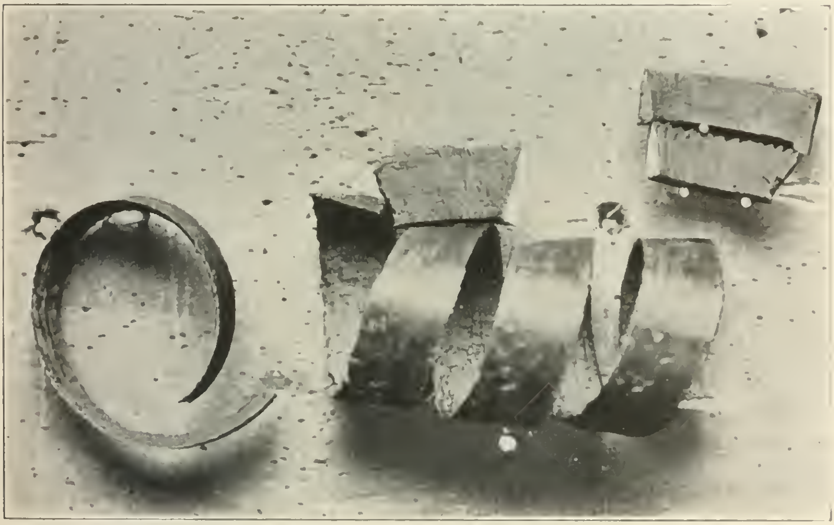
The tool-holding device of whatsoever kind is vitally important, not only to the proper performance of the work, but to the life of



EXAMPLES OF CHIPS MADE BY A HIGH-SPEED PLANER.

The specimen above, cut at a speed of 40 ft. a minute, the chip being $\frac{1}{2}$ by $\frac{1}{4}$ in., shows regular but very slight vibration. The under side is very smooth, showing a clean cut. In the large chip below, $\frac{3}{8}$ by 1 in., vibration is very pronounced and irregular. Note the back of the chip.

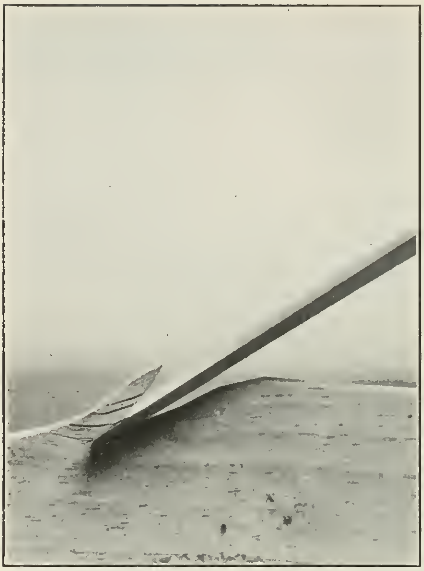
the tool as well. At the very best the tool and holder together are in the nature of a spring acting under tension when at work. It is commonly inferred that if no chattering is heard or felt there is no vibration present. As a matter of fact vibration is rarely, if ever, absent, even in such tools as drills, reamers, and millers. A careful study of the structure of steel chips shows at once the nature and extent of the quivering. In general it is found that the more rigid the combination of machine, tool, and holder, the fewer and less pronounced the serrations and cleavages apparent in the chip. If also the tool is sharp and has considerable rake, these markings, caused chiefly by the quivering of the tool, are still less evident, though not wholly absent.



AN EXAMPLE OF SMOOTH CUTTING.

Vibration is practically absent. The back of the chip, however, shows the work to have been done by a dull tool with little rake, "pushing" the metal off rather than cutting it.

The importance, with respect to the finished work, of reducing this quivering to its lowest terms is obvious. It is no less important to the tool itself; for this it is that destroys the cutting edge of the tool and makes it necessary to re-grind more or less frequently according as conditions approach the ideal. Under true ideal conditions the tool would practically sharpen itself while cutting, and its life be greatly prolonged. As the prolongation of the life of the tool is one of the chief reasons for the use of high-speed steel as a tool material, it is desirable to set the tool at work under the conditions most favorable to the accomplishment of that object.



AN EXHIBITION OF THE ACTION OF A CUTTING TOOL IN WOOD.

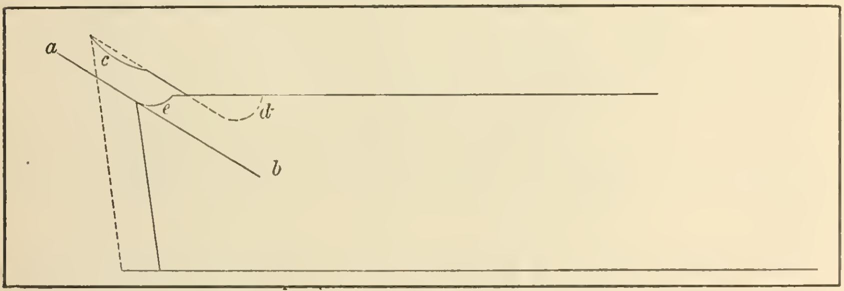
Unless the grain prevents, the line of cleavage tends toward the surface in front of the tool, and the cutting edge is continually lifting new fibres as it advances, and establishing new lines of cleavage.

A finishing tool works with either a splitting or a shearing action (or more often a combination of the two) at right angles with the finished surface. The scraping action frequently seen is only a modified shearing action. The splitting action is readily seen in the case of wood and other materials of a fibrous nature. The edge of the tool lifts the fibres, opening a crack which precedes the cutting edge at a greater or less distance according as the tool is blunt or acute and the chip brittle or tenacious. In so-called cutting of metals, the conditions are very similar, though of course they are much less noticeable because of the less fibrous and more granular structure of metals. The cutting edge of the tool enters the mass of metal and acts somewhat like a wedge, the point of cleavage being in advance of the point of the tool. But as the line of cleavage is bound to be more or less irregular, and in the case of cylindrical work or cutter its direction is constantly changing, the cutting edge must lift up and split off in the same way the smaller particles forming the rough surface under the lifted chip.* If the tool has at the same time a lateral motion, as where the cutting edge is somewhat inclined to the plane of the cut, like that of a spiral milling cutter, there is a sort of scraping or shearing action also, leaving a relatively smooth surface. This is also the reason, it may be mentioned incidentally, why steel may be machined at a greater speed than cast iron and similar brittle materials. In the case of the latter, the chip is so brittle and there is so little fibre that

* It may be mentioned that there is no essential difference between the chip cut by a high-speed tool and that produced by ordinary ones. Such differences as are apparent are for the most part superficial and due to the higher speed at which the chip is curled, rather than to the manner of separating it from the piece being finished. The interest attaching to this circumstance is chiefly that it refutes the earlier impressions gained on the first introduction of high-speed steels. With the earlier tools only rough work was attempted, generally with tools so shaped that the metal was pushed off rather than cut, as the term is generally understood in metal working. Under those circumstances, of course, chips behaved somewhat differently, and there was some justification for the belief that high-speed tools worked with an action different from that of carbon and self-hardening steel ones.

the point of cleavage is only very slightly in advance of the tool point, and is tending constantly toward the surface of the chip instead of moving in the direction of the cut. In consequence the edge of the tool has much more work to do than when cutting steel, in which case most of the work falls upon that part of the tool just behind the cutting edge, where the tenacious chip rubs against the well supported rake surface, and where, in consequence of the constant abrasion, the tendency is to wear a depression or pit and therefore continuously to renew the cutting edge.

Now the pit mentioned is nearly always present on tools (working on steel and similar materials) having little or no rake; but when there is a considerable slant to the surface along which the chip slides off, it is not usually noticeable. Furthermore the angle which the front surface of the pit holds, to the direction of the cut, is tolerably uniform for the same material and conditions of work. The obvious inference would be that the natural angle thus established should be used always, in order to secure greatest efficiency. There are however other considerations; and one of the most important is that already mentioned—the vibration or quivering attending most, if not all, cutting operations.



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AN ILLUSTRATION OF RAKE IN CUTTING TOOLS.

The line a b indicates the slant or rake which in this particular case would allow the tool to work at its highest efficiency, for it is the slant established by the abrasive action of the chip itself. The dotted outline indicates the proper outline for the tool required in this case. Notice the difference in the pits c and e behind the cutting edges. These are, of course, exaggerated in the figure.

If these vibrations took place in the same direction as that of the cut, there would be small harm; but from the nature of the tool-holding arrangement it is never exactly so, being more nearly in the form of the arc of a circle; and furthermore, the stress of the work tends to push the tool away from the work, so that by far the greater amount of quivering is about at right angles with the direction of the cut. The cutting edge of the tool is therefore receiving a constant succession of blows from the under side of the lifted chip, which tend to break it over very much as is the case when scraping a piece of wood with a freshly broken piece of glass. For this reason it is necessary frequently, perhaps generally, especially when the tool is used on a machine somewhat worn, or not well designed for high duty, to sacrifice efficiency in cutting by using a tool with little rake, in order to secure backing enough to prevent this crumbling of the cutting edge.

The natural thing to do, apparently, is to stop the vibration and thus permit the tool to work at its greatest efficiency. But for reasons already pointed out this is generally impossible without the installation of new equipment designed with reference to this particular end. Expedients for the mitigation of the evil are for the most part of little avail. That of giving the tool just enough clearance to allow it to ride upon the finished surface is frequently of advantage, particularly in the case of lathe work when the point of the tool may be set a trifle above the center line. Another expedient that is often helpful is to increase the feed, or better still the depth of the cut. In light cuts, if there is any possibility of springing either tool or work the tendency is for the tool to ride upon the unfinished surface more or less and thus do an imperfect job.

Nothing dulls a tool faster than this riding over the work and trying to scrape the surface. A sharp tool is not so likely to do this as one already slightly dulled. Evidently, then, it is desirable to keep the tool sharp when doing this kind of work—that is, when cutting a thin chip. With respect to this, however, there arises the question of how often it is profitable to grind the tool. Evidently frequent grindings are economically undesirable in that they occasion the loss of much time. The paradoxical alternative is to give the tool more work to do —that is to increase the feed or depth of cut, or both.

The philosophy of it is that a heavy cut puts the tool under a stress great enough to take up all the slack and spring in the circle of parts extending from the point of the tool, through the tool-holding device, the frame of the machine, and to the point on the surface of the piece machined where the tool does its work. Obviously an increase in feed alone does not necessarily overcome the difficulty, for if the cut be light it may still be possible for the work or tool to spring sufficiently to allow the one to scrape the other instead of cutting it. It is therefore better to give an increased depth to the cut also. This generally reduces, if it does not wholly eliminate, the lateral vibration and thus saves the cutting edge of the tool from crumbling, as well as increases the accuracy of the work.

It may sometimes be necessary, when this is done, to decrease the speed somewhat, to reduce the total amount of work at the cutting point to the maximum which the machine will stand or pull, or which the nature of the work itself allows. The saving in scrap and time lost in grinding however much more than compensates for this.

The necessity for increasing the depth of cut raises another question—that of the extent to which it is desirable to rough forge or cast parts which are later to be machined. In the case of castings, whether of gray or malleable iron, the removed metal may be used again in the melting furnace with practically no loss; so that there is nothing particular to gain by molding these parts close to size. On the other hand, as already shown, it is desirable that they be oversized sufficiently to allow the finishing tool to get a good grip, so to speak, on the metal, and to make reasonable allowance for warping and imperfect coring. Excess of size beyond these requirements merely occasions the unnecessary eating up of power at the machine.

In finishing malleable castings, however, it is to be remembered that the skin is the toughest part, and that if this is removed to a considerable depth the casting loses much of its strength because the interior is not, like the surface, of a close, steely grain. It is quite safe, however, under ordinary circumstances, to take a finishing cut of 1/16 inch, which is also sufficient to give the tool a good hold. The same depth is ample in gray-iron castings, unless they be quite large or so peculiarly shaped as to warp easily or be likely to be badly cored, when suitable further allowance is to be made.

In the case of forgings, however, there is to be considered the possible additional cost of making forgings close to the ultimate size. As to the cost of making a forging, a little reflection and observation will show that no more time is required to size properly a drop or other die forging than to leave it over size. As a matter of fact, most such forgings must conform, in the parts not to be machined, to a fixed standard anyway; so that in this respect the portion to be finished can just as well as not conform to the conditions pointed out as desirable in the case of castings.

It is different with large forgings—those made to specifications, and mostly by hand. Here the time required for close forging becomes an important item—the closer the forging, the greater the time, relatively. For such work it is undoubtedly more economical to forge only approximately to size, and let a heavy machine "hog off" the superfluous metal from those parts which are to be finished anyway.

All that has thus far been said with respect to chattering and vibration applies to carbon-steel tools as well as to those of high-speed steel; but the latter are affected even more than the former, so that the proper setting and grinding of tools is a matter worthy of serious attention. Just how a tool should be shaped or ground or set for a particular job, it would be absurd to say dogmatically. The proper relation of these points depends upon so many conditions that experience alone can determine what they shall be for any particular job or class of jobs. About all that can be said at present, in a general way, is that for cast iron and similar materials, it is better to give the cutting tool less rake and more backing than is permitted in machining the more tenacious materials. In cutting steel the highest efficiency is obtained (the work, the tool, and the holding arrangement being sufficiently rigid to allow of it) by giving the cutting edge a rather sharper angle than has heretofore been customary.

These considerations would indicate that the re-grinding and re-setting of tools should be done with care greater than that which can usually be given in the average workshop. That is to say, for many kinds of tools it is not good practice to allow them to be ground at haphazard on the shop emery wheel, by the workman using them. Lathe and similar tools having but a single cutting edge, the angle of which may vary slightly without material disadvantage, may well be so handled. But the case is different when there are several cutting edges, as in drills, reamers, and milling cutters, whose efficiency depends among other things upon the uniformity of those edges and the consequent equality of work required of each.

Reamer grinding, for instance, is usually done by the workman using the tool. All the apparatus he has is an emery wheel and a rest to support the tool while grinding. The cutting angle and evenness of the lips when ground are wholly dependent upon the workman's judgment and keenness of eye. Under the circumstances there is absolutely no chance that there will be any considerable uniformity in the lips, with the result that those ground away the least take deeper cuts when working and therefore do much more work than the others. Of course these lips wear away much more rapidly than the others, shortening the life of the grinding and sometimes unfavorably affecting the accuracy of the work. In the case of a milling cutter any such irregularity would obviously be manifest in the milled surface. Good practice therefore indicates that for this class of tools at any rate it is desirable to arrange a system whereby they may be ground in the tool room; or if not there, anyway by some one provided with suitable appliances for duplicating a given edge with uniformity.

As previously pointed out, hot alloy steel must be kept from contact with water, otherwise it will be checked and cracked very much as glass is under similar circumstances. It is therefore unsafe to allow the ordinary workman to grind such tools except on a dry grinder. It is true that the maker of certain high-speed tools insists that the inserted teeth must be ground on a wet wheel. But the condition under which this is possible is a thorough flooding of the wheel and a very gradual feed against the wheel. The slightest crowding will heat the tool in spite of the flooding, and the result is a spoiled edge, which crumbles under the stress of its work.

Even on a dry wheel the average workman will be very likely to spoil the tool because he all but invariably crowds it against the wheel and very quickly heats the edge unevenly, so that microscopic checks are developed which may later cause it to crumble easily. This is not however a thing that cannot be prevented, and dry grinding is generally the only safe method. If wet grinding is for any reason desirable or necessary, soda or soap water should be used.

Often there is considerable trouble with high-speed tools just when starting them to work, especially in small ones. Within a few minutes of starting, the tool may break or, more likely, show a crumbled edge. The reason is that high-speed steel is much tougher when moderately hot than when cold. A hot tool therefore will stand more work than a cold one, especially if the cutting edge have a rather sharp angle. If the tool be started at ordinary speed, with comparatively light feed, and gradually worked harder and faster for a few minutes, it will quickly " warm up " to its work, with no likelihood of breakage or impaired cutting edge. In larger tools, or rather in those having considerable metal close to the cutting edge, such disintegrating action is unusual, even if they are started without a preliminary " warming up." In all cases however, a little caution does not go amiss.

The matter of lubricants and cooling agents for use with high-speed tools has been previously considered (in the first article of this series) and therefore need not be again discussed in this place. It is perhaps sufficient to repeat that lubricants are usually unnecessary and cooling agents superfluous, when cutting steel as well as castings. If for any reason it is desired to make use of them, the usual soda or soap water will answer. Oil does no harm—and little, if any, good.

THE OCCURRENCE AND DEVELOPMENT OF THE COBALT ORE DEPOSITS.

By J. A. Macdonald.

The Cobalt ore deposits are among the most interesting now engaging the attention of the mining world. Mr. Macdonald has spent the past twelve months prospecting and surveying in northern Ontario, and his review of the field is based upon his own study and observation, though in the more technical portion, and especially the mining geology, he draws his data in part from other sources and authorities and is under obligations particular to the Ontario Provincial Government reports, to Professor Nichol, of the Kingston School of Mines, and to the Geological Survey Department.—THE EDITORS.

THE Cobalt ore bodies, which carry values in silver, cobalt, nickel, and arsenic, were discovered during the building of the Temiskaming and Northern Ontario Railway. In fact, it may be said that the railway discovered the deposits, as it runs almost over the top of what is probably the most important vein yet found. The finding of ore so rich within a short distance of the shore of Lake Temiskaming, a stretch of water which has been a well-travelled route to the North by white men for two hundred years or more, and the existence of the deposits only about four miles from the town of Haileybury, show the possibilities there are for the discovery of important mineral-bearing areas in the vast hinterland of Ontario, much of which is little known. The chief of these ore bodies which have been worked lie within half a mile of what is now known as Cobalt station, distant by rail about 103 miles from North Bay junction on the Transcontinental line of the Canadian Pacific, and 330 miles almost north of the city of Toronto. It may also be added that one of the oldest known ore bodies in North America, the argentiferous galena on the east side of lake Temiskaming, is distant only 8 or 9 miles from Cobalt station. This galena deposit was apparently discovered by voyageurs over one hundred and fifty years ago. A map of the lake published about 1778 has a bay marked on it with the name "Anse à la Mine" thus showing that the deposit was known at least at that date and probably much earlier, owing to the fact that the ore outcrops at the water's edge and is of such a character as to attract attention.

Some of these veins in the vicinity of Cobalt station were apparently noticed by the men employed in railway construction in the spring of 1903, but, there being no miners or prospectors among

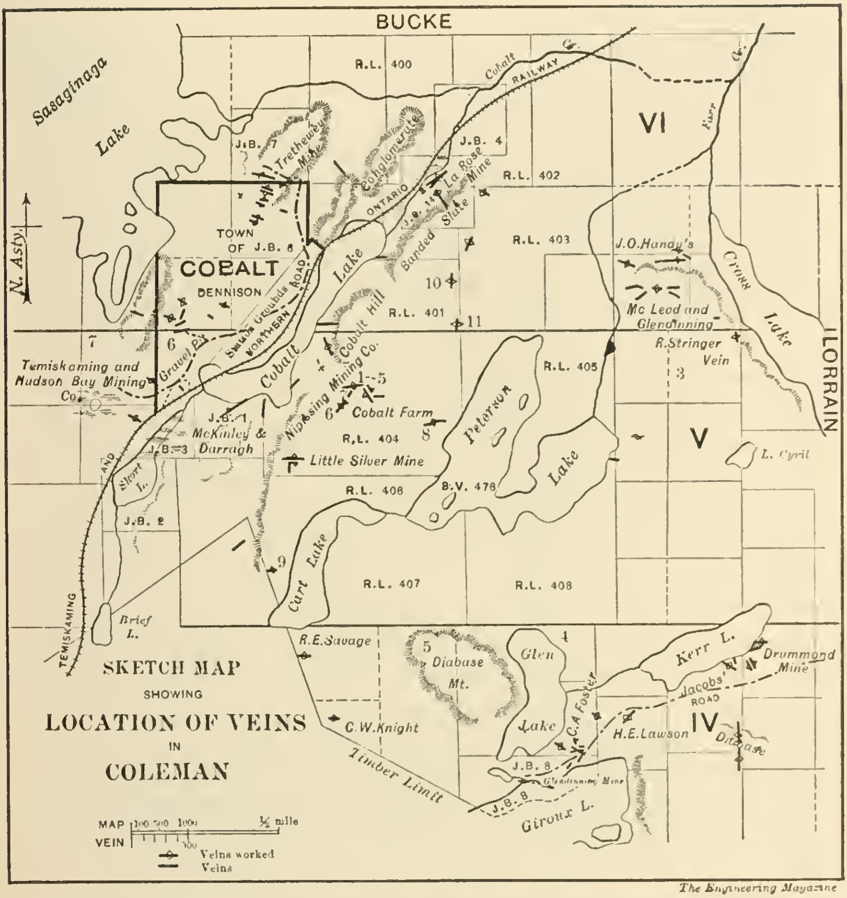

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FIG. I. SKETCH MAP OF THE COBALT REGION.

Following one presented in the Fourteenth Report of the Bureau of Mines.

them, little interest was aroused and nothing was heard of the discovery by prospectors until October of the same year. At that time Mr. T. W. Gibson, director of the Bureau of Mines, then in that part of the Province, was given a sample of niccolite which the donor thought was copper ore, the color of this mineral being like that of copper as the German name, *kupfernickel,* indicates. This mineral niccolite had been found some years before in association with the lower grade nickel ores of some of the Sudbury deposits, but no great quantity of it has up to the present been discovered in the Sudbury field, the town of which name lies about 90 miles southwest of Cobalt station. The deposits at Cobalt, on the other hand, occupy narrow, practically vertical fissures or joints which cut through a series of usually slightly inclined metamorphosed fragmental rocks of Lower Huronian age. A few veins, of similar form, have also been found in the adjacent diabase. Some of the recently discovered veins near the centre of location R. L. 404 (page 407) appear to be partly or wholly in the Keewatin, which is here in contact with the Lower Huronian.

The material in these veins has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and were probably associated with the post-Middle Huronian diabase and gabbro eruption. It is rather difficult to predicate the original source of the metals—silver, cobalt, nickel, arsenic and others—now found in these veins. They may have come up from a considerable depth with the waters or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analysis of various rocks of the area have not given a clue as to the origin of the ores. As these ore bodies in the vicinity of Cobalt station may be said to be unique among those known in North America we have no chance of instituting comparison on the western continent. Some European veins, however, such as those of Annaberg, Joachimsthal and other localities show a similar association of minerals. The origin of these has been explained by most authors by the supposition that the metals were leached from the surrounding rocks. From the descriptions which have been published of most of these European occurrences, it appears that there are usually basic dikes in the vicinity of the veins. These dikes appear to have, in some cases, the same relation to the ore bodies that those of diabase and gabbro have in the Ontario cobalt region.

Ores.—The chief ores are native silver, smaltite or diarsenide of cobalt, niccolite or arsenide of nickel, chloanthite or diarsenide of nickel, associated with which are argentite or sulphide of silver, pyrargyrite or sulph-antimonide of silver, dyscrasite or antimonide of silver, erythrite or cobalt bloom, annabergite or what may be called nickel bloom, millerite or sulphide of nickel, native bismuth, tetrahedrite or sulph-antimonide of copper and other metals, mispickel or sulph-arsenide of iron, and occasionally graphite. Erythrite and annabergite are the hydrated arsenates of cobalt and nickel respectively. They are both decomposition products. Asbolite and other minerals of similar origin are present. The more common minerals, galena, copper pyrites, iron pyrites, and zincblende, together with oxide of manganese, occur in small quantities, especially in the country rock. Other minerals are found, but generally in such an impure form that their characters have not been definitely determined. Calcite is the chief vein stone, but some of the veins have little even of it. Quartz and fragments of the wall rock are found in some of the ore.

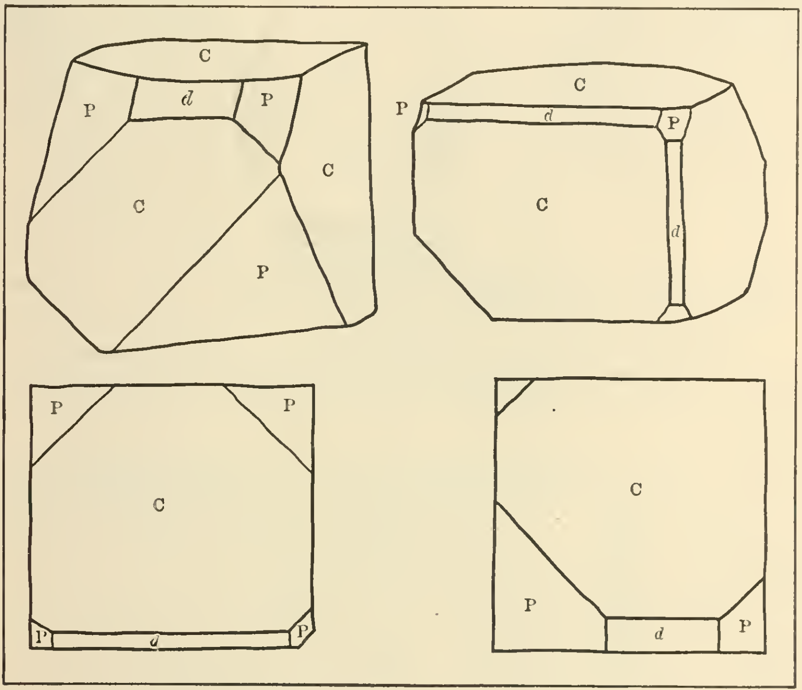

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FIG. 2. SMALTITE CRYSTALS FROM THE COBALT HILL MINE.

C, cube; P, Octahedron; d, rhombic dodecahedron. After Professor Nichol.

The outcrops of the veins usually show native silver and cobalt bloom. The latter is a good indicator, its delicate pink color having a striking appearance. It is apt to be confused only with certain tints of red oxide of iron. If the bloom is, however, carefully heated, which can be done in the cover of a tin can over a camp fire, it will be found to turn blue. If fused with borax it imparts a beautiful blue color to the resulting glass. The native silver exposed at the outcrops will, of course, be tarnished. Its color can be determined by cutting it, and its weight is characteristic. Native bismuth, with fresh surfaces, looks like silver, but is more easily cut, and on exposure tarnishes a reddish color. The other important mineral in the above list which is not brittle and is easily cut is argentite. Prospectors have mistaken it for lead, but it is black in color.

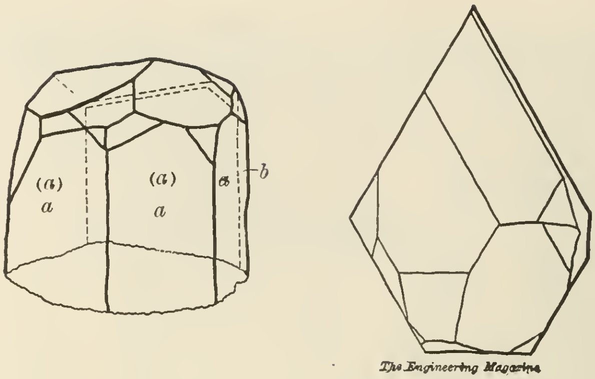

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FIG. 3. PYRARGYRITE CRYSTALS FROM LA ROSE MINE.

"The crystals occur as an incrustation on the surfaces of chinks or cracks in the country rocks intimately associated with argentite or silver glance.—PROFESSOR NICHOL.

The veins are narrow (the width of the ore averaging in the veins which have been worked, probably 10 or 12 inches) and may be easily passed over by those accustomed to prospecting in other fields. Fragments of rock should be frequently broken off the ledges. Bloom has been discovered by this means in outcrops where its presence was not suspected. Cracks in rocks should be cleaned out with a prospecting pick. A vein of these ores, a few inches in width, is worth much labor.

Shipments.—From five veins which have been opened up during the last few months, in an area which is less than one mile in length from north to south and about one-half mile in breadth from east to west, surrounding Cobalt station on the recently constructed Temiskaming and Northern Ontario Railway, something like $400,000 worth of ore has been shipped. With one exception—the vein on the north of R. L. 404 near Cobalt lake—all these veins carry high values in silver, besides important amounts of cobalt, nickel and arsenic. The composition of shipments (carloads) from one of the silver-bearing veins (1). and from the vein which does not carry silver values (2) is seen from the following results of analyses:

(1)

	Per cent
Silver	11.41
Cobalt	11.27
Nickel	3.78
Arsenic	44.16

(2)

	Per cent
Cobalt	15.60
Nickel	7.00
Arsenic	61.74

Silver brings about 60 cents per Troy ounce, and about 90 per cent of the value is paid for the metal in the ore. Cobalt has sold for 60 to 65 cents, nickel at 12 to 15 cents, and arsenic at about 1 cent a pound in the ore.

The Cobalt-Silver Veins.—It is considered unnecessary to give a detailed description of each vein in the district, the character of one being usually so much like that of another. Many veins have recently been discovered, especially on the older properties. Scarcely any of the veins have been stripped for their full length. Most of those worked have been developed in the form of open cuts. The vein first discovered on the La Rose claim J S 14, on which several others have since been found, has been developed more systematically than any other in the district. A shaft has been sunk and about 250 feet of drifting has been done at the 90 foot level, following the vein in both directions from the shaft. The drifts prove that the vein is at least as large and as rich at this depth as it has ever been. In the 250 feet the drifts have passed through comparatively little barren ground. Approximately $1,000,000 worth of ore has been blocked out on this vein. The ore body here is one of the largest developed in the area, but the Nipissing company is the largest mining property in the field and promises large-scale operations. The La Rose ore differs somewhat from that of the other veins in that it contains a higher percentage of niccolite, the nickel averaging about 10 per cent.

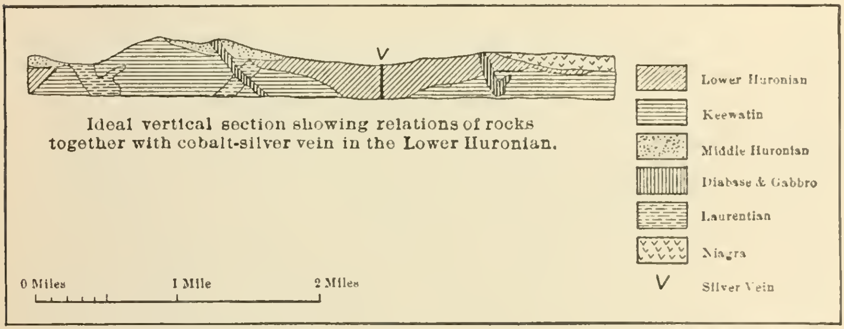
V
Ideal vertical section showing relations of rocks together with cobalt-silver vein in the Lower Huronian.
Lower Huronian
Keewatin
Middle Huronian
Diabase & Gabbro
Laurentian
Niagra
V
Silver Vein
0 Miles
1 Mile
2 Miles

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FIG. 4. A TYPICAL GEOLOGICAL SECTION SHOWING THE OCCURRENCE OF THE SILVER VEIN.

To give an idea of the character of the ore of one of the other veins it may be said that an open cut, about 50 feet long and 25 feet deep, on the Tretheway vein, location on plan, J. B. 7, has produced approximately $200,000 worth of ore, the maximum width of the vein being not more than 8 inches. The amount received for one car load of 30 tons of ore from this mine, at the prices for the contained metals mentioned elsewhere in this review, was between $75,000 and $80,000. A shipment of 50 tons of the ore gave on analyses approximately the following percentages of metals: arsenic, 38; cobalt, 12; nickel, 3.5; and 190,000 ounces of silver. Pay was received for cobalt and silver only.

Most of the cobalt-silver veins occur in what is called the Lower Huronian. A few have been found in the diabase. There is no reason so far apparent why the veins should not also occur in the underlying Keewatin, and some of the more recently discovered ones, near the centre of location R. L. 404, appear to be in this group.

The more important veins so far found in the Lower Huronian lie in what may be called three parallel belts. Those first discovered are in a belt which runs about parallel with the railway in the vicinity of Cobalt Lake. A small belt connects the northeast corner of Peterson lake with the northwest corner of Cross lake. A third belt stretches from Giroux lake to the southeast end of Cross lake, in which important deposits occur. These three belts have a strike approximately in a northeast and southwest direction.

Dimensions.—The veins are all narrow. The ore in the Tretheway vein on J B 7, for instance, had a maximum width of about 8 inches, while the vein in the northwest corner of R L 404 has 14 inches of ore, and that on J S 14 showed about 18 inches. Some veins which have been traced 100 feet or more average not more than 1 inch in width.

The surface, being uneven and more or less covered with loose deposits and with green timber, does not afford an opportunity of tracing the outcrops of the veins any great distance, and it is not known definitely how long most of the outcrops would prove to be if the material referred to were removed from the surface of the rock.

It is also impossible to give much definite information concerning the depths to which these veins will reach. As already said, most of them do not appear to cut through the older Keewatin series which forms an uneven surface below the Lower Huronian. In the vicinity of Cobalt station the latter rocks are found on hilltops which stand about 500 feet above the low-water level of Temiskaming where similar outcrops are found.

The depth to which a vein may reach depends, therefore, on whether it descends into an old valley of the older rocks or whether it lies above a former hilltop.

One shaft is already 70 feet, another 90 feet, while a diamond drill has been driven 340 feet into La Rose, and in each instance pay streaks held out. Inasmuch as the camp and the ores found here are new things in the mining world, scarcely any man knows or can know the extent of the find until the whole district, including the northern watershed, has been prospected. In the meantime Nature has been so generous it seems she should be trusted so long as the pay dirt lasts. In a space of 25 feet and 50 feet long in the Tretheway mine, as much as $200,000 worth of silver ore has been extracted.

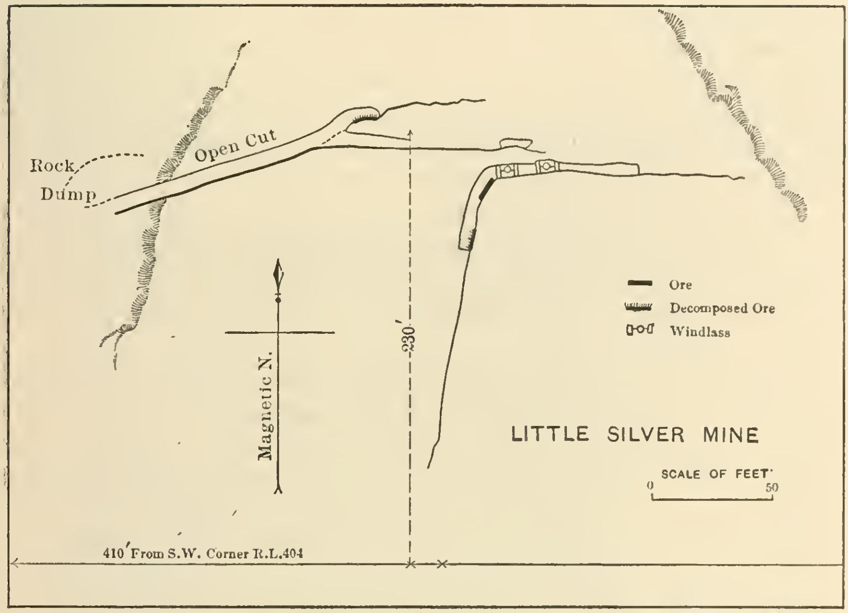

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FIG. 5. SKETCH MAP OF WORKINGS, LITTLE SILVER MINE.

So far as surface indications, real nuggets, and ore in sight, are concerned, Cobalt is the richest silver camp on the continent. Cobalt is intoxicating. It is so fabulously rich in silver that men are apt to fancy they can go up to the new camp, strike a claim, and begin shipping ore. But it is not quite so easy as that. The prospector going to Cobalt should be prepared to travel the rough unbroken trail. There are also lakes and swamps and great wide rivers, cold and damp, and many other obstacles.

Distribution of Ores.—A peculiar occurrence of cobalt and nickel with gold has recently been discovered on Rabbit lake, east of Temagami and about 30 miles south of Cobalt station. The outcrop is at the water's edge and the deposit has not been uncovered back from the shore. The rocks here have been more disturbed and are much more highly metamorphosed than are those in the vicinity of Cobalt station. They appear, however, to belong to the Lower Huronian conglomerate-greywacke series. The ore body, about 18 inches wide, is in a zone fracture. An analyses of some of the more highly mineralized material gave the following results:

Arsenic	22.53
Cobalt	8.76
Nickel	6.56
Gold	$8.80 a ton.
Silver	1.10 "

This unique deposit is of interest since it shows that cobalt-nickel ores are to be looked for so far south of Cobalt station. The Rabbit lake occurrence is about the same distance south of Cobalt station as the ores of the township of Ingram are north of it, thus showing that the cobalt-nickel ores are distributed over a distance of at least 60 miles in a north and south direction.

Mining claims are numbered on the map thus: J. B. 1, R. L. 400, etc., the initials representing the surveyor's name. Mining claims 40 acres in size on lots which were surveyed prior to the location of the claims are not numbered, but their boundaries are shown on the map. (See page 407.)

Character of Surface.—Most of the southern half of the mapped area contains green timber. Lumbering operations have been conducted over all this area with the exception of the Lumsden & Booth timber berth. Much of the field is covered drift deposits, and the exposures of compact rock are frequently clothed with moss. In the field it is difficult at times, to distinguish these greenstones from the slaty-greywacke member of the Lower Huronian, especially if the latter has been subjected to pressure. Only a rapid traverse was made through the timber berth which lies immediately to the east and to the south of the Montreal River. The surface is uneven. Hills with steep faces frequently rise to a height of a hundred feet or more.

Prospecting.—A prospector entering the district in search of cobalt-silver deposits should first make himself familiar with the various classes of rocks, otherwise he may spend his time on the least promising outcrops. Good exposures of the Keewatin greenstones are to be seen along the shore of Lake Temiskaming immediately to the south of Haileybury, and along the line of railway between Cobalt lake and Bass lake. The latter exposures contain numerous small cracks filled with white calcite, which assist in distinguishing these rocks from the near-by rather massive greywacke slates of the Lower Huronian. A typical variety of the diabase or gabbro, later in age than the Huronian, is to be seen in the first rock cut on the railway south of Haileybury. Between this cut and Cobalt station there are several exposures of the conglomerate, with granite and other pebbles, and of the slate-like rocks of the Lower Huronian. A good contact between the latter series and the Keewatin with porphyry dike, is exposed on lot 15, concession 11, of Bucke, on the shore of Temiskaming. The Lower Huronian here rests on Keewatin and contains pebbles and angular fragments of greenstone and porphyry, thus clearly showing the unconformity between the two series. A contact of the Lower Huronian with the Middle Huronian is to be seen on lot No. 4, concession XII. of Lorain. Angular blocks, or shingle, of the former are cemented in the arkose of the latter.

The terms Lower and Middle Huronian are here used provisionally. The formations have not been correlated with those to which the names are applied in the vicinity of the north shore of Lake Huron and elsewhere.

A great variety of minerals is found in the veins, and the prospector should visit some of the working properties near Cobalt station and become acquainted with the general character of the ore.

Investors Flocking In.—Gentlemen from New York in Newmarket coats rub elbows with others from San Francisco, Chicago, and Detroit, while several Montreal and Toronto syndicates have had men upon the scene quietly picking up promising properties wherever they may be obtained. Two mines in Coleman township are owned and operated by Montrealers, the Drummond and Jacobs mines. These two lie side-by-side on Kerr Lake, about three miles southeast of the camp, and almost directly east of the famous Diabase Mountain. Nearby on Giroux lake, is the famous University (or Glendenning) mine.

A couple of young graduates from the School of Science, Toronto, were surveying in the neighborhood about the time the original strikes of silver were made. They immediately did some prospecting, and as a result located the mine mentioned. As high as a million and a half has been offered for it and refused. In appearance these mines at first, like all the others, disappoint the uninitiated. The approach to them is interesting enough.

One drives for a couple of hours over a winter road, grazing stumps and tree trunks and passing groups of prospectors who, with pick and " steel " upon their backs, are setting out, in spite of the snow, to their claims On every side from the working claims comes the noise of blasting and the ring of iron on steel, as the miners prepare for a " charge."

Precipitous hills, almost impossible to climb, give one an instant reward when finally the top is gained. For miles and miles the forest stretches away toward Lake Temiskaming, the intervening country dotted with a dozen tiny lakes. Then a clump of frame buildings is seen. One is the " bunk-house," where the miners sleep; another is a " grub-house", where they eat, while off, at some little distance, stands a frame building, with a long smoke stack protruding through its roof.

Inside the building all that is seen is a yawning hole topped by a windlass to raise the ore bucket. A small engine operates the windlass. There comes a whistle from the depths, and in a few seconds a huge bucket filled with pieces of dirty-looking wet rock is dumped upon the floor of the shaft house. Loaded into a wheelbarrow, it is carried to the ore house, where a couple of men break it into smaller lumps and bag it in rough sacks. It is only when a piece of the dirty-looking rock is handled that one realizes its value. Upon the broken surface of the piece of rock one sees a myriad of little bright specks. If you rub your finger over it they prick it. " Three thousand dollars to the ton," the captain of the mine will remark, as he handles the chunk with a knowing air.

The Cobalt district is soon to have a great ore smelter and refinery. It will cost $60,000, and the Ontario government has agreed to give the projectors a free site on the Temiskaming railway, between Cobalt and North Bay. The smelter and refinery is expected to be in operation in October next. The great trouble with the cobalt ores heretofore has been the problem how to smelt them without wasting one or other of the metals or minerals contained. Silver, cobalt, arsenic and nickel are all present in considerable quantities in most of the ores, and the mine owners were getting nothing for some of the products at the smelters in New Jersey, where all the ore so far has been sent. The projectors of the Cobalt smelter turned to Germany for an object lesson, and found that for five centuries Saxon ores have been successfully treated which contain cobalt, arsenic and silver. The process is a secret one, but an arrangement was come to by which a license is granted to carry it on in Canada on condition that the process shall be in charge of two German experts to be sent out by the Royal Geological Institute of Berlin. One of these gentlemen has arrived, and surveyors have lately located the site of the smelter. So far only the silver has been paid for, and nothing has been received for the cobalt, nickel, and arsenic. When this smelter gets working, it is the intention to pay for all the products recovered from the ore at a regular fixed tariff. The total output from the Cobalt mines for 1905 was in the vicinity of $2,000,000.

EDITORIAL COMMENT

THE report of a majority of the Senate Committee on Interoceanic Canals, favoring a sea-level project, marks a new stage in the preparatory consultations; we greatly fear it will prove the inspiration to further delay rather than to immediate physical progress. The slender majority in committee can scarcely carry their recommendation through against the firm conviction in favor of the summit-level project which preponderates in the judgment of the Administration, of all but one of the Commission, of the chief engineer, of (it is said) a large majority of the House of Representatives, and of (we believe) the greater part of the engineering authority of the country, whether represented by the technical press or by individuals. Some notable exceptions to this last category must be recognized, among whom the former chief engineer, Mr. John F. Wallace, stands high in honorable distinction.

Anyone who followed the testimony before the committee can well understand that the volume of matter presented and the honest divergences of opinion between various witnesses might—nay, probably must—produce much perplexity in the minds of laymen unqualified to weigh the authority of the several engineers appearing before them, or in some instances to distinguish between professional opinion and personal animus in the testimony given. The impressive confidence of certain of the witnesses seemed to be in inverse proportion to their authority in, or experience and familiarity with, the very special questions involved. Worse yet, the evidence offered in other instances was—to the shame of the profession be it said—distinctly unfair. Add to these disturbing influences that of a sudden and as yet ill-digested impression from the San Francisco earthquake, and one seems to have a pretty good conspectus of the controlling influences behind this report.

Awed by bogeys and confused by irrelevancies and mares' nests, the majority turn with a sense of secure relief to the comfortable phrase "sea-level." Why? Because they fear an earthquake might "fracture the locks" of the summit-lake canal. But the so-called sea-level canal would also have locks, at Sosa, subject to similar fracture. Why next? Because they fear the possible failure of the Gatun dam, sustaining the summit lake at a level of 85 feet above the sea. But the so-called sea-level canal would be absolutely dependent upon the Gamboa dam, holding the Chagres in a great lake 180 feet above the sea, and almost overhanging the canal. Truly, there is much in the names given to things. To the sentiment carried by the image of a true sea water way, we believe, is due in large part the majority decision in favor of a project which, in our best judgment, really affords the poorer solution of the engineering problems involved and the least efficient medium for the uses of navigation. Neither in its tenor nor in its expression does the majority report add much to the world's wisdom in the matter of the Panama Canal.

* * *

It is sincerely to be hoped that the overwhelming majority by which the House passed the Free Alcohol Bill will be taken to heart by the Senate as voicing the National appreciation of the importance of the measure, and the public demand for its passage. At the outset, however, it seemed to encounter there an opposition which, in view of its source, was universally attributed to the Standard Oil interests. Their objection to anything which held the prospect of breaking their monopoly over the market for fluids suitable for burning in lamps, or for use in internal-combustion motors, was held to be not indirectly related to the efforts made to reopen entirely new hearings in the Senate, and generally to make it impossible for the bill tc reach passage at this session.

Rather hastily and at least semi-officially, however, it was denied on the part of the Standard Oil Company that they had any desire to retard the bill or any interest whatever in it, one way or another. Probably the history of the "Octopus" does not encourage confidence in its sincerity in any policy so broad-minded as this would imply; but unquestionably there is unlimited room for the industrial use of alcohol without prejudice—indeed, with ultimate advantage—even to the sellers of oil and benzine. In any case, it is now announced that the bill has been favorably reported to the Senate by the Committee, with some amendements as to penalties only. Each one may draw his own conclusion as to how far this result was influenced by the flare of anger which swept across the country when the obstructive policy of Senator Aldrich was first reported. The temper of the people towards the Standard Oil Company is not such that it would be wise to fan it by further agitation.

Rarely, indeed, does any economic legislation open so many doors of opportunity as this. The puzzle is that the Nation has so long been blind to its own interests. We do not generally look to Germany for greater industrial alertness than we find at home, but she has long led us in this particular field. By recent reports, there are in the German Empire now more than five thousand internal-combustion motors in use in stationary power plants, running on denaturized alcohol, besides all those employing the same fuel on automobiles. And this is only one of the directions in which cheap grain alcohol would benefit industry. Not the least, as we remarked in a recent issue, is the relief of thousands of workers from the deadly poisoning effects of wood-alcohol fumes—an evil almost comparable to the long-denounced and practically outlawed phosphorus and mercury diseases. And every use found in the industries or arts means added opportunity for agriculture. Nothing should be permitted to stand in the way of the passage—and the speediest pcssible passage—of the bill now in the Senate.

* * *

We have already referred in these columns to the comparative uselessness of automobile races, so far as the improvement of the mechanically propelled vehicle is concerned; since the qualities which conduce to high speed bear comparatively little relation to reliability, efficiency, or convenience. It is interesting to note that this view is being generally shared both in Europe and in the United States by the various organizations having control of automobile trials, and following the initiative of the Automobile Club of France, the different associations are giving attention to various reliability tests.

One of the most interesting of these tests is undoubtedly that conducted last month by the Automobile Club of America upon the efficiency of gasoline motor cars, the basis of the test being the effective energy developed by the consumption of two gallons of gasoline.

Such a test is valuable for several reasons. The amount of fuel corresponds to that which can be conveniently carried by an ordinary light vehicle, so that the results are of immediate interest to the whole body of automobilists. By measuring the charge of fuel beforehand, all necessity was removed for using any refined methods of testing fuel consumption during the run, the quantitative results being determined simply by noting the distance run, the control being effected automatically by the exhaustion of the fuel supply. Each machine also received a rating based upon its powering and load, so that nothing further was necessary than the statement of the distance traversed, a quantity capable of being checked at any time thereafter beyond possibility of controversy.

The results of the trials proved beyond doubt the value of such tests by the wide-spread interest with which they were received. The winning car, the Franklin, carried two passengers for a distance of 87 miles before the two gallons of gasoline were consumed, while results not far short of this were attained by other vehicles. In order to show that the result obtained by the winning car was not due to any special circumstances, the same machine was given a second independent test, in which it covered 95 miles upon a fuel supply of two gallons of gasoline, so that the figures appear to be reliable. It is considered significant that out of the five cars which covered the greatest distances in these trials, four were air-cooled, demonstrating the fact that water-cooling is not necessary for practical road vehicles.

* * *

The development of the ocean steamship goes on apace, and the record tenure of each "greatest vessel afloat" appears to be briefer than ever. Hardly has the giant *Amerika* made her maiden trip than her still bigger sister, the *Kaiserin Auguste Victoria* leaves Hamburg for New York. The latest of the "greatest" ocean liners has a length of about 700 feet, a breadth of 77.6 feet, and a depth of 54 feet, the total displacement being 43,000 tons, with a gross register of 25,500 tons.

It is interesting to note that vessels of this type are exceedingly popular with the traveling public. Equipped in all respects as elaborately as the most magnificent of modern hotels, and providing for every comfort and convenience for the passengers, vessels of the type of the *Amerika* or the *Auguste Victoria* go out with full passenger lists at rates which are both possible to the general traveller and profitable to the company. The capacity of such a steamer will be appreciated better when it is understood that the *Auguste Victoria* carries 550 first-class, 300 second-class, and 2,300 steerage passengers; and, including the crew of 650, this floating city carries very nearly 4,000 people, the population of a considerable town. The speed is such that the crossing from England to America is accomplished within a single week, and there are few who will find this time too long to spend upon such a stable, safe, and complete vessel. Speed may be necessary for the rapid handling of the mails, and for the convenience of those to whom the sea is a source of discomfort and dread, but with the increase in dimensions and stability, this latter class is rapidly diminishing in numbers. Apart from the large economy effected by the lower powering which the moderate speed makes possible there is also gained valuable cargo capacity, the *Auguste Victoria* being capable of carrying 16,000 tons of freight.

* * *

The Chattanooga meeting of the American Society of Mechanical Engineers may be considered as a success in many ways. The historical associations and the scenic beauties of the location, together with the cordial welcome extended to the visitors, combined to render the four days most agreeable to those who were privileged to attend the meetings, while the papers presented and discussed were worthy contributions to the Transactions of the Society.

We have reviewed elsewhere in this issue the important series of papers upon the speed regulation of various kinds of water-wheels, and among other contributions to the Transactions we may here note the most important series of investigations by Professor Stewart upon the collapsing pressure of lap-welded steel tubes. As a consequence of these experiments the author has been able to derive a formula representing the facts with a far higher degree of accuracy than has hitherto been the case, and there is little doubt that the older rules and formulas will become obsolete, and replaced by the one which these investigations produced.

Among the excursions provided by the local committee for the entertainment of their guests, the most important, from an engineering viewpoint, was that to Hale's Bar, below the city of Chattanooga on the Tennessee river, where there are under construction important improvement works, including a dam to aid in the navigation of the river, together with the development of 50,000 horse power of energy, for electrical transmission to Chattanooga and vicinity.

The membership of the Society in the vicinity of Chattanooga is but small, but it is a pleasant experience with these midsummer meetings that they are almost invariably followed by welcome additions to the membership from the locality where the meeting is held.

* * *

In this connection it may be a matter for note that there are many reasons why, at this time, the membership of the American Society of Mechanical Engineers should be largely increased. At the present time there is a total membership of about 3,000. That this represents all the engineers in the United States who are eligible for membership, cannot be admitted. There are many men who, by training, experience, and general qualifications should associate themselves with this National society, and both receive the benefits which membership will confer, and give of the experience and ability which they possess, to the advancement of the profession in this country.

By the close of the present year the Society will enter upon the occupancy of its share of the magnificent Union Engineering Building which, through the generosity of Mr. Andrew Carnegie, one of its honored members, the Society is one of the founder societies. With this change in its location the Society is destined to grow still more rapidly in the future than it has in the past, and notwithstanding the rigid professional requirements which are demanded for membership, it is destined to include in its roll a far greater number of the engineers of the country than has hitherto been deemed possible. Not to be a member of the American Society of Mechanical Engineers, when one is by education, experience, and general ability fully qualified, is to fail to appreciate the opportunity which exists to grasp the highest standing which the profession offers; it is to miss the ultimate goal which should be the aim of every man who believes in the advancement of his own share in the applied science of engineering.

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On the 27th of April last the Committee on Coinage, Weights, and Measures, of the House of Representatives, decided, by a vote of 8 to 4, not to report favorably on the Littauer bill for the compulsory introduction of the metric system of weights and measures into the Departments of the Government, and thence into all workshops.

This disposes of the question for the present Congress, but it will be necessary for continual vigilance to be exercised against the schemes of those who are endeavoring to slip some additional metric legislation through Congress.

Every American manufacturer and engineer should be on his guard to see that none of the underground methods which have been adopted in the past shall fail to be checked, until this insidious movement is absolutely dead.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE GAS TURBINE.

A REVIEW OF THE THERMAL AND MECHANICAL CONDITIONS UPON WHICH THE PRACTICAL SUCCESS OF THE GAS TURBINE IS DEPENDENT.

L. Sekutowicz—Société des Ingénieurs Civils de France.

THERE has been observed of late in various quarters a disposition to disparage work upon the gas turbine and to indicate that while the question might be all very well for mathematicians and laboratory scientists to use to occupy their time, it could not possibly interest the practical man. That this is not the opinion of some very competent engineers, however, is beginning to be realized, and there is no doubt but that, at the present time, there are a number of patient investigators as well as thorough scientists who are fully convinced that the gas turbine, before very long, may bear the same relation to the reciprocating gas engine as the steam turbine does to the older forms of the steam engine.

In a recent issue of the *Mémoires* of the *Société des Ingénieurs Civils de France* there is given a paper presented before the society by M. Sekutowicz, discussing the whole subject of the gas turbine, from a historical, thermodynamic, and practical view, showing that important developments should be expected from the earnest work which is being given to this motor by the investigators who are working upon its practical development.

The term gas turbine includes such heat motors as are intended to convert heat into mechanical energy by the expansion of a gaseous mixture upon the wheel of a rotating turbine. The idea of thus utilizing the expansive forces of heat upon gases is very old; probably the most ancient application of the principle appears in the mediæval turnspit, in which a sort of propeller wheel in a chimney was caused to revolve by the current of the ascending gases, this motion being transmitted by chain or other gearing to the spit upon which the roast was revolved before the fire. In the modern sense, however, probably the first gas turbine was that devised by M. Burdin, who, in 1847, proposed to construct a sort of hot air turbine, operated by the flow of heated air through a multiple-wheel turbine, the supply of heated air being kept up by the action of a similar set of multiple blowers.

The real beginning of modern turbo-machines, both for gas and steam is undoubtedly due to the communication of the French engineer, Tournaire, to the French Academy in 1853, in which he discussed the multiple-wheel turbine in general, and evidently realized the difficulties which were involved on the perfection of the gas turbine, but also said that its success would include a revolution, not only in the quantity of combustible consumed, but also in the equally important reduction in the masses of material involved in the construction of such machines.

Coming down to the actual conditions involved in the problem of the gas turbine, M. Sekutowicz shows that such machines may be classified according to the manner in which the heat is carried through the cycle.

Thus, there may be employed the Carnot cycle, and its derivatives, as already used in reciprocating motors by Diesel; the principal difficulty with this being the high degree of compression required to secure the approximate cycle.

The second method is that of using the isobaric cycle, corresponding to that used by the so-called combustion motors. This involves the use of an isothermic compression carried up to 30 or 40 atmospheres rejecting adiabatic compression.

The third cycle is defined by M. Sekutowicz as the isopleric cycle, being a cycle of constant volume, corresponding to that of the explosion motor. Theoretically this should give the same results as the isobaric cycle, with the advantage of requiring a much smaller compressor, but its application to the gas turbine appears problematic.

In practice the compressor offers the principal difficulty, and upon its efficiency the relation of total to the useful work largely depends. As a matter of fact the gas turbine is a machine characterized by a high thermal efficiency and a low mechanical efficiency, but M. Sekutowicz believes that it is capable of showing a net efficiency fully equal to that of the Diesel motor, by far the most efficient heat engine which has yet been produced.

The author shows that with the gas turbine, as with the reciprocating internal-combustion engine, the best result should be attained with high compressions, by the rapid introduction of heat (about 500 calories per kilogramme), and by an exhaust temperature of about 700 degrees C., absolute, and he then proceeds to discuss the mechanical arrangements by which these conditions may be most nearly approximated. Various auxiliary appliances have also been suggested, of which M. Sekutowicz discusses the following. Regeneratives cycles have been employed, in which the heat of the exhaust gases has been used to give a preliminary heating to the compressed gases before delivery to the combustion chamber. In this way a machine may be made with an improved thermal efficiency without modifying in any way the mechanical efficiency or the importance of the compressor. Another plan has been to prolong the expansion by using an exhaust pump to lower the exhaust pressure, but this does not improve the total performance.

Another auxiliary process is that of injecting water or steam into the acting gases. This may be effected in various ways. The water may be injected into the combustion chamber, or beyond the expansion nozzle. Water may be injected directly into the combustion chamber with a possible improvement in performance, but a far better plan is to inject high-pressure steam from a boiler heated by the exhaust gases. In this way, using a pressure of 40 atmospheres, M. Sekutowicz states that an efficiency of 0.26 may be increased to 0.34, other conditions being equal.

Another plan suggested has been to use the heat of the exhaust gases to operate a second machine, somewhat on the principle of the so-called binary vapor engines, but it has been found that better results are obtained in utilizing this heat in machines on the regenerative principle.

A study of the laws of the adiabatic expansion of gases in nozzles shows that the velocities of discharge are somewhat higher for gas than for steam, ranging from 1,500 to 1,600 metres per second for an exhaust temperature of 700 degrees C., absolute, so that the power obtainable from a given nozzle is greater for gas than for steam. In this connection M. Sekutowicz discusses the probable losses by friction, showing the methods for computing the mechanical efficiency of machines of this type, as well as the different manners in which the speed and power may be regulated.

The most interesting portion of the paper, however, is that relating to constructive details of gas turbines, including the compressor, the combustion chamber, the various systems for regeneration, and the rotating wheel itself.

The compressor is one of the most important elements in a successful gas turbine plant, since it is a negative charge upon the efficiency of the machine, and it is most desirable that it should have a high efficiency itself and be as simple and effective as possible. As a high efficiency of the whole plant is largely dependent upon a high compression of the charge the compressor must be able to compress the initial charge of air, or of air and gas, to about 40 atmospheres, the air and fuel charge being maintained in the combustion chamber at a pressure of about 10 atmospheres, and exhausted from the turbine wheel at atmospheric pressure or below.

Of course it would be most desirable to have a rotary-air-compressor capable of delivering the air and fuel at the required pressure, but at the present time this has not been found practicable. Rotary compressors, based upon the same principle as multiple centrifugal pumps, have been designed, but it is with difficulty that such machines have been made to deliver air at a pressure of 20 to 25 atmospheres, the large number of wheels required, and the frictional losses caused by the revolution of the wheels at high speed in dense air, causing the efficiency to fall off below the best rate.

Reciprocating compressors are yet the most reliable, although it detracts materially from the advantages of a rotary machine to have a reciprocating machine attached to it, and for the present at least, this must be allowed. So long as efficiencies of 70 to 80 per cent are to be obtained from reciprocating compressors these will have to be considered, at least until some more efficient form of rotary compressor is produced.

The combustible used in a gas turbine may be solid, liquid, or gaseous, but, for the present it appears unlikely that solid fuel will be employed directly, owing to the injurious effects of the ash and non-combustible portion upon the turbine wheel. Solid fuel may best be used in a gas producer, the gaseous fuel being compressed and delivered to the combustion chamber in a manner similar to that employed for the air. The most successful work at the present time has been effected with liquid fuel, but there appears to be no good reason why compressed gas may not be employed with equal success.

Producer gas, the waste gases from blast furnaces, and all similar fuels are available for use in the gas turbine, and with the coming liberation of alcohol from the burden of repressive taxation, a new source of energy, of such wide-spread possibilities as to render it beyond the control of favored monopolies, will be released to become a source of power in combustion motors of all types, for the benefit of mankind.

The fuel, be it liquid or gaseous, is introduced, under pressure, with the air, into the combustion chamber, and this chamber should be of sufficient dimensions to insure a complete combustion, before the gases which are the products of combustion are delivered to the expansion nozzle. The velocity at the nozzle will vary from 500 to 800 metres per second, as the temperature of combustion ranges from 1,000 to 2,500 degrees centigrade, absolute. Since the velocity of propagation of flame at atmospheric pressure, is from 1 to 2 metres per second it is desirable to have the cross section of the combustion chamber about 100 times that area for a compression of 25 atmospheres and a temperature of 2,000 degrees absolute, since these conditions give a density of about ten times that of the exhaust for the pressure in the combustion chamber. The total volume of the combustion chamber must be determined by experience, this indicating a length of 5 to 10 times the diameter.

The construction of the nozzle through which the hot gases are expanded calls for notice. This should be made of a material capable of resistance to high temperatures, to chemical reactions, and to expansion and contraction stresses, besides having a fair mechanical resistance. Experience has shown that these properties are possessed fairly well by carborundum, the principal difficulty with this material being its conductivity for heat. A diverging nozzle is found to be the best, with a rectangular section, and the extremity may be made of metal, since the temperature at that point has fallen to about 800 degrees absolute, well within practical limits.

The turbine wheel itself need not differ materially from the form developed for use with steam. Single or multiple-disc wheels may be used, the arrangement being such that perimeter speeds of 150 to 200 metres per second are not exceeded. Experience has shown that temperatures of 500 to 600 degrees centigrade absolute may be used with safety, always taking care to use materials of which the tensile strength is not diminished too much at such temperatures. The best results have been obtained with a nickel-steel alloy of which the resistance is not materially affected for temperatures up to 700 degrees absolute. Nickel steel is also found to have a good resistance against the oxidizing effect of the stream of hot gases, a point of material practical value.

THE PREVENTION OF DISASTERS IN MINES.

METHODS AND APPLIANCES FOR COMBATING AND PREVENTING DISASTERS FROM FIRE AND EXPLOSIONS IN MINES.

H. Schmerber—Le Génie Civil.

IN view of the terrible disaster at the Courrières mine, attention has again been called to the necessity for providing every practicable means for preventing the occurrence of similar accidents in coal mines; or, such events having taken place, to provide the most effective appliances for meeting the great emergencies in the most effective and prompt manner. In a paper in a recent issue of *Le Génie Civil* M. H. Schmerber discusses the various kinds of accidents which may occur in mines and the best methods of preventing loss of life and for rescuing those in the pits.

Mining disasters are divided by M. Schmerber into two great classes, the first including explosions either of fire-damp or of explosive mixtures of coal dust and air, and the second covering broadly the disasters by fire, flooding, land slides and miscellaneous operative accidents. Of these the first, namely explosions of fire-damp has been the most important and disastrous in its consequences. Thus, since 1889 there have been, in Great Britain and on the Continent twelve great mining explosions from this cause, with losses of life reaching 290 in the highest to 55 in the lowest, not including the Courrières affair, of which the correct statistics are yet to be had. The list given by M. Schmerber does not profess to be complete nor to include many similar disasters, but serves to show the magnitude of the danger from this source.

Fire-damp, as is well known, is a gas disengaged in coal measures the composition being similar to methane, or marsh gas, containing about 70 to 85 per cent of pure CH_4. When mixed with air this forms very explosive mixtures, the maximum degree of explosiveness corresponding to 6 to 10 per cent of fire damp.

The formation of fire-damp cannot be controlled, although its presence may be diminished by ample ventilation, but the best preventive of disaster from this cause lies in the removal of means by which the explosive mixture can be ignited. Since the invention of the safety lamp it has generally been supposed that the danger from ignition of fire-damp by miners' lamps has been obviated, but as a matter of fact it is shown that nearly 53 per cent of the explosions, according to the statistics discussed by M. Haton de la Goupillière, have been caused, either by the exposure of the naked flame of the lamp to the gas, or by the unauthorized use of matches.

The modern safety lamp has been brought to a high degree of perfection, and the results of the trials at the official testing station at Framéries, in Belgium, reviewed in these columns in January last, show that explosions caused by the ignition of gas from mining lamps may be classed as preventable, if the best modern precautions against opening the lamps are observed, and if appliances for relighting extinguished lamps in explosive atmospheres are provided.

Miners themselves appear to have that recklessness which comes from long familiarity with danger, and unless prevented by mechanical means, they appear to be liable to open lamps, even in the very presence of the explosive gas, so that it is not sufficient to provide them with safety appliances, but this must be supplemented with every possible mechanical safeguard, which can be devised.

Next to the lamps, the mining explosives used for blasting must be considered as possible sources of gas ignition. This was a more important matter when the older forms of black blasting powder were used than at the present time, with the modern mining explosives.

Many experiments have been made in France, England, Germany, and Belgium upon the so-called permitted safety explosives for mining purposes, and there is no doubt that much has been accomplished in this direction as regards safety. M. Schmerber calls attention to some points in this respect, however, which appear to be worthy of special attention. Thus, the aim of compounders of safety explosives is to lower the temperature of the explosion below that at which any surrounding mixture of gas and air will ignite. This end is usually accomplished by the employment of ammonium nitrate, sometimes in a fairly large proportion, the presence of the crystallized salt acting to lower the temperature of the explosion. This plan, however, is found to diminsh the power of the explosion and also to lower the sensitiveness of the powder to ignition to such an extent as to increase very materially the proportion of miss-fires, themselves always a profitable cause of subsequent disaster.

M. Schmerber speaks very highly of the value of the *grisoumètre,* as an indicator of the percentage of explosive gas in the atmosphere of a mine, believing that the true method of protection is the maintenance of a pure atmosphere so far as is possible.

The danger from dust explosions, once strongly questioned, has been fully demonstrated, and a number of cases are cited to show the necessity of employing preventive measures against such risks. The best plan appears to be a frequent sprinkling of the floors and walls of the mine in such a manner as to cause the dust to cake and become compacted together, thus preventing the mingling of finely divided combustible with the air of the mine. Various plans for keeping the passages clean have been proposed, but such methods usually result in the stirring up of the dust, thus only making matters worse. It does not appear that the vacuum method of dust removal has been tried for this purpose, but it might be practicable to keep the atmosphere of a mine free from dust by employing some modification of this principle.

One of the most difficult forms of disaster to contend with in a mine is fire. It is to this category that the terrible affair at the Courrières mine appears to have been originally due and it is in this connection that the question as to the possible methods of prevention and protection of fire danger demands immediate attention.

When a proper supply of water is available the usual plan is to construct light defensive barriers and to attempt to extinguish the fire by jets of water. If the fire has made material progress it is sometimes closed off by barriers, while the adjacent coal is cut away as rapidly as possible, in order to check the progress of the combustion by removing the fuel. The most general plan at the present time, however, is to shut off the burning section of the mine by strong barriers and by thus excluding the access of air, to cause the fire to smother itself with its own products of combustion. This operation, however, is surrounded with many difficulties. The high temperature produced by the combustion, and the ignition of the gases formed by the distillation of the coal, often cause the accumulation of a high pressure behind the barriers, causing dangerous outbreaks. Even if the fire is actually extinguished behind the barriers, the greatest precautions must be exercised in opening up the enclosed space, since the dissipation of the heat is very slow and the fire is very apt to break out again.

The Courrières disaster appears to have been a combination of fire and of gas explosion. Probably an enclosed fire reached an accumulated mass of gas in the older portion of the workings, and this again was followed by ignition of the dust in the air. The large amount of dust, produced by the force of the first explosion, becoming ignited, developed great volumes of carbon monoxide, in itself poisonous, while the force of the explosions completely disorganized the whole ventilation system of the mine. The destruction of the partitions' by which the air was directed down one shaft and through the mine to the uptake shafts to the ventilators, caused the suction effect of the fans to act to draw the suffocating gases through all parts of the mine, and this is believed to account for a large part of the loss of life.

Apparently the only completely efficacious method of fighting fire in a mine is by the isolation and flooding of the burning section, and this can only be accomplished effectively by a previously planned system of partitions and water supply. The subject is one of the most difficult problems confronting the engineer at the present time in connection with mining operations, and may well demand the attention of the ablest members of the profession.

M. Schmerber discusses other sources of accidents and disasters in mining operations, and shows the imperative necessity for the overhauling of the internal arrangements of the older mines.

THE CONDENSATION OF STEAM.

PRACTICAL METHODS FOR IMPROVING THE EFFICIENCY OF SURFACE CONDENSERS FOR USE WITH STEAM ENGINES.

Professor R. L. Weighton—Institution of Naval Architects.

IT is not often that the professor is ahead of the practical engineer. Usually the laboratory work in engineering institutions follows the work of the commercial designer, and tests are made to determine the performance of devices which have already been put into practical use, telling the man who built them how good or how bad they are. We have, at the present time, however, an agreeable surprise in the form of a paper, presented before the Institution of Naval Architects, by Professor R. L. Weighton, discussing experiments made upon surface condensers, and showing how the efficiency of such apparatus may be immensely improved. These experiments, made in the laboratory of Armstrong College, Newcastle-on-Tyne, may well be taken as an example by the directors of similar laboratories elsewhere, showing them how the work of instruction may well be combined with that of original investigation to an extent which shall enable the builders of machinery to make improvements in their methods with the encouragement of scientific authority.

A high vacuum has always been the desire of the engine builder, and now, with the demands of the steam turbine, this is more than ever the case. But the vacuum must not cost too much, either in water or in power, or it will be purchased too dearly. Professor Weighton has shown experimentally how the quantity of water required by a surface condenser may be reduced to a minimum, and how the maximum efficiency of the cooling surface may be attained.

The engine at Armstrong College is a vertical quadruple-expansion marine engine, with attached condenser and air pump of the ordinary marine type, and for the puroses of the experiments the improved condensers were placed close to the engine and connected so that the general operative conditions could be kept as nearly as possible uniform for the different trials.

The original condenser was made with tubes ¾ inch in diameter, four feet long, the condensing water circulating twice through them giving an effective length of tube of 8 feet, the total condensing surface being 170 square feet. The new condensers were of a different type, the three condensers being similar and differing mainly in dimensions and surface. Two specific features appeared in their design, one being that the condensing water passed several times through the tubes, these being arranged in four or five groups, so that a much greater effective tube length was attained than with the old type for the same surface, while the other feature was that of provision for draining the different parts of the condenser in sections, instead of permitting the condensed steam to accumulate at the bottom. This sectional drainage was effected by dividing the interior into compartments by diaphragms somewhat inclined to the horizontal, thus directing the water formed by the operation of condensation to be drained off directly at the sides instead of permitting it to flow from the upper tubes over those beneath.

The importance of this arrangement will be seen when it is remembered that the greater part of the condensation in the ordinary condenser takes place in the upper part, where the steam impinges first upon the tubes, and this provides for drawing off the water from this portion without allowing it to flow over the lower tubes to the detriment of their action. Other features of the new type condensers are the avoidance of a large steam space at the top, providing such a passage as will just secure the distribution of the incoming steam over the tubes, together with such general internal shape as will best promote the flow of the steam over the whole tube surface.

The first of the new condensers was made with the same cooling surface as the old type, namely, 170 square feet, but it immediately appeared that, with the new design, this was much more than was necessary. A second similar condenser, with but 100 feet of cooling surface was made, and this proving of ample size for the amount of steam to be handled, a still smaller one was constructed, having tubes only 2 feet 6 inches long, through which the water circulates four times, giving an effective tube-length of 10 feet, the total cooling surface being only 62 square feet, and this was found fully equal to the work.

The results of the tests are fully given in the paper in the form of curves and in tables, to which the reader must be referred, but the general lessons of the trials may be given here as useful to designers.

So far as actual performance is concerned, the old condenser, of 18 feet cubic capacity and 170 square feet of cooling surface, maintained a vacuum of 28 inches of mercury with a consumption of 43 pounds of water per pound of steam, the rate of condensation being 10 pounds of steam per square foot per hour. The new style condenser, having 100 square feet of cooling surface, and a cubic capacity of 9.6 cubic feet, or only about one-half that of the old one, required only 24 pounds of water per pound of steam condensed, and condensed 20 pounds of steam per square foot per hour; that is, the cooling surface was twice as efficient, with a consumption of but 56 per cent the amount of water. The smaller condenser of the new type, while fully capable of handling the steam produced by the engine, took somewhat more cooling water, the consumption being 32 pounds of water per pound of steam, but the efficiency of the cooling surface was higher, the rate of condensation being 33 pounds per square foot per hour, while the space occupied by this condenser was only 6 cubic feet, or one-third that of the original one built for the engine.

The average consumption of the engine was 12 pounds of steam per horse power, and at this rate the proportion of the several condensers may be estimated. Thus the original condenser had 1.2 square foot of cooling surface per horse power, while the larger condenser of the new model had 0.6 foot, and the smaller one 0.36 foot of cooling surface per horse power, taking, as above noted 12 pounds of steam per horse power per hour.

"Surface-efficiency is at the root of all efficiency in a surface-condenser. That condenser is the most efficient in which each square foot of surface transfers in given time and conditions, as to water supply, &c., from the steam to the water, the largest number of heat units. This will, moreover, be the condenser which will not only register the highest vacuum, but will maintain it at the least cost in condensing water, and with the smallest surface and cubical capacity per pound of steam condensed. It will also, in given conditions, be the one to yield the highest hot-well temperature. Now, in order that a surface may thus act, it is necessary that the steam should have free access to, and should pass over, sufficient surface on the one side, and that all the condensing water should come into direct and efficient contact with the surface on the other side. This clearly cannot be the case if on the steam side practically the whole surface is continually subjected to showers from the water of condensation, or if the steam can short-circuit any material amount of the surface; nor can it be the case on the water-side if the condensing water flows through the tubes in unbroken cylindrical streams, the peripheries of which streams alone come into actual contact with the tube surface, and a greater or less proportion of water-core passes through without efficient contact. Hence the augmented efficiency of the surface as a whole, due to the early interception and removal of the feed-water, the provision for promoting steam circulation, and the adoption of a suitable ratio between the surface and the water-carrying section of each tube element."

In order to bring the cooling water into intimate contact with the surface of the tubes Professor Weighton introduced into each condenser tube a core of wood of triangular section this forcing the water to the inner surfaces of the tubes and preventing the flow of a core of idle water through the centre. It is thus seen that the new condensers were designed with the special object in view of attaining the highest surface efficiency, and the greater this efficiency the less the quantity of condensing water required per pound of steam condensed.

"Economy of water is important from several points of view. First, as in the case of land installations, water may itself have to be purchased. Second, it has to be pumped through the condenser; and any saving in water means, other things being equal, power economy in vacuum production. Third, water may have to be cooled for repeated use, and in this case surface-efficiency of condenser has a double effect. Not only is there less water to be pumped, but owing to its higher outlet temperature there will be a greater mean difference between the temperature of the water to be cooled and the air which cools it; and hence cooling towers will be more efficient, and may therefore be of smaller size for given power.

Another important result of enhanced surface-efficiency is, of course, economy of condensing surface. Owing to steam space being dispensed with in the new type, a given surface is contained in less capacity of condenser-shell. These two features conduce to economy of weight and capacity. From the point of view, therefore, of weight and space occupied, the new type of condenser has important advantages, which would seem to render it peculiarly adapted for use on board ship, and specially so for all classes of war vessels, in which both weight and space are of supreme importance."

In connection with these condenser tests, these involving some four hundred carefully conducted trials, the subject of air-pump efficiency and proportions was considered, various types of air pumps being tried. In general it appeared that, when the system and piping is fairly tight, a pump capacity of 0.7 cubic foot per pound of steam condensed is as good as anything larger, but when air leakage exceeds a certain amount, larger pump capacities are necessary for the maintenance of the required vacuum. No apparent advantage appeared from the use of compound air pumps.

In general the following conclusions appear to follow from the experiments, as applicable to the design of condensers of maximum efficiency.

" 1. It is conducive to efficiency in a surface condenser that the water resulting from condensation should be intercepted and removed from the condenser as soon as possible after it is formed.

"2. It is conducive to efficiency that the condenser capacity should be a minimum consistent with the accommodation of the necessary surface, and that the design should be such as to secure a pervading and uniform flow of vapour throughout the condenser section, thus utilizing the whole of the condensing surface provided, as well as obviating stagnant recesses in which air might be retained.

" 3. It is conducive to efficiency that the condensing water should travel at a fairly high speed through the tubes, and that it should enter at the bottom and leave at the top of the condenser.

" 4. With suitable condenser design and proportions, the temperature of the condensing water at the discharge point may be equal to, or slightly higher than, the temperature due to the vacuum. This holds true for vacua up to slightly over 29 inches.

" 5. With suitable condenser design and proportions, the temperature of the hot-well may be from 3 degrees to 5 degrees higher than the temperature due to the vacuum. This holds true for vacua up to slightly over 29 inches.

" 6. With suitable condenser arrangements and a reasonably air-tight system, there is nothing gained in efficiency by the use of air-pumps exceeding in capacity 0.7 of a cubic foot per pound of steam condensed, up to a limit of close upon 29-inch vacuum. For vacua exceeding this limit, or for cases in which air-leakage is considerable, the air-pump capacity must be increased, or else the vacuum-efficiency will fall.

" 7. With suitable condenser design and proportions, and in conjunction with dry air pumps, a condensation rate of at least 20 pounds of steam per square foot of surface per hour will be maintained in association with a vacuum of 28½ inches, and a quantity of condensing water equal to 24 times the feed water, at an inlet temperature of 50 degrees.

"8. With suitable condenser design and proportions, and in conjunction with dry air pumps, a condensation rate of at least 36 pounds of steam per square foot of surface per hour will be maintained in association with a vacuum of 28½ inches, and a quantity of condensing water equal to 28 times the feed water, at an inlet temperature of 50 degrees.

BRITISH COAL RESOURCES.

THE PRACTICAL PRINCIPLES INVOLVED IN COAL CONSERVATION, POWER TRANSMISSION, AND SMOKE PREVENTION IN GREAT BRITAIN.

Arthur J. Martin—Society of Arts.

ABOUT a year ago we reviewed in these columns the report of the Royal Commission appointed to investigate the important question of the nature and probable duration of the coal supplies of Great Britain, this report indicating that at the present rate of working the existing available coal resources should provide for the requirements of the next 200 years; this taking the limit of practical working depth at 4,000 feet. We now have an interesting paper, presented before the Society of Arts by Mr. Arthur J. Martin, emphasising the supreme importance of husbanding the coal resources of the United Kingdom, and discussing some of the most important examples of waste, with their remedies.

Mr. Martin calls attention to the fact that the supply of coal will naturally not be cut off short at any definite period, but that in consequence of the increasing cost of production the price will gradually rise until it is found that imported coal can compete with the home product, much in the same manner as the source of grain supply has gradually been transferred, during the past century, from the agricultural districts of Great Britain to the imports from abroad. At the present time England is dependent upon foreign supplies for about two-thirds of her food supply, and as the countries from which these supplies are drawn are filled up these sources will become restricted. The same may be expected in connection with the coal supply as soon as the increasing depth and cost of mining renders competition possible.

The principal burden of Mr. Martin's paper is that this evil day may be long postponed by the prevention of a large portion of the present enormous wastes accompanying the consumption of coal for industrial and for household purposes.

"Whether the impending coal famine sets in 20 years hence or 200, it is not a thing to which we can look forward with satisfaction; and the historian of the year 2100 is not likely to form a favorable judgment of the ancestors to whose extravagance his own generation owes its deprivation of one of the prime necessaries of life.

"Looking at the matter from its ethical side, it may well be questioned what right we, as mere tenants for life and trustees for the generations to come, have to squander their share, as well as our own, of an inheritance which has taken untold ages to accumulate, and which, once lost, can never be replaced. If any question of the kind is raised, it is apt to be met by glib talk of some new discovery, such as the utilisation of radium, or of the solar rays, whereby we shall be enabled to dispense with coal.

"The Commissioners devote some space to a consideration of the possibility of finding an alternative source of energy, and come to the following conclusion, 'we are convinced that coal is our only reliable source of power and that there is no real substitute. There are, however, some possible sources of power which may slightly relieve the demand for coal.'"

The fuel consumption in Great Britain may be divided into three parts: that used for power production, estimated at about one-half the total; that consumed in industrial operations other than power, using three-tenths; and that used for domestic purposes, taking one-fifth.

Mr. Martin shows in a popular way, by means of diagrams what the engineer also knows by experience, that the most economically designed steam boilers and engines succeed in utilizing only about 14 per cent of the energy in the coal consumed; this partly because of the lack of efficiency of the mechanism, but largely because of the thermo dynamic principles involved in the conversion. This efficiency, however, is by no means attained by the majority of engines and boilers, and it is probably safe to say that instead of consuming between one and two pounds of coal per horse-power, the average consumption of steam engines in Great Britain is five pounds per horse-power-hour; while small, and neglected engines use as high as 30 pounds and more. There is here a means of saving at least one-half of the coal consumed in power generation, or one-fourth of the total consumption in Great Britain, simply by using good for bad engines.. If gas engines were substituted for steam power, it would be easy to secure a better economy with small engines than is now possible even with the best and largest steam engines, and a consumption of one pound of coal per horse-power-hour might become average practice.

In industrial operations and in domestic service it is easily apparent that fully double the amount of coal is consumed than is necessary to obtain the amount of heat required, and for these purposes also a corresponding economy would be secured by the use of gaseous, instead of solid fuel. The great benefit arising from the entire abatement of smoke production consequent upon the abadonment of solid fuel should also be considered, and this phase of the question was fully discussed by Mr. Martin in this paper presented before the Royal Sanitary Institute, and reviewed in these columns in March last.

All considerations, then, point to the desirability of substituting gaseous for solid fuel, and this point once conceded the full measure of its possibilities begins to appear. Instead of conveying the coal, at much expense for transport, to the vicinity of the large cities, the possibility of producing fuel gas at, or near the collieries at once suggests itself. Oil is conveyed many hundreds of miles through pipe lines, and in the natural-gas districts of the United States gas is delivered to great distances under high pressures. There is, however, an additional advantage, suggested by Mr. Martin, which demands thoughtful consideration. The transmission of power by compressed air is an operation well-known and successfully conducted. In mining operations, tunneling, etc., compressed-air transmission is a standard method of operation. In Paris the power-distribution service of the compressed air company is an old established business.

"From power transmission by compressed air it is but a short step to the conveyance of gas under pressure for the same purpose. The mode of transmission is the same in both cases; but as regards the medium employed the advantages of gas over air are overwhelming. Working at a pressure of six atmospheres, as in Paris, a good motor requires some 550 cubic feet of air per indicated horse-power per hour; in a gas-engine 14 1-3 cubic feet of ordinary lighting-gas will do the same work. The specific gravity of lighting-gas being only four-tenths (taking air as unity), the volumes of the two fluids carried by the same main will be in the proportion of 16 to 10, if the initial and terminal pressures respectively are the same in both instances. This, however, would not be the case, for, whereas with air a small part only of the initial pressure is employed for transmission purposes, every pound of pressure consumed in this way being so much less available for working the motors, in dealing with gas the whole power of the compressors may be used to force the gas through the pipes, the power to be realised at the receiving end depending, not merely on the pressure of the gas as received, but chiefly on its calorific value. By reason of these various advantages, a main and compressor-plant dealing with gas will transmit no less than 150 times as much power as could be sent by means of air. Add to this the fact that the use of compressed air is practically limited to the production of power, whereas gas serves also as a source of light and heat, and it will be seen that the commercial possibilities of compressed air, great as they are, dwindle into insignificance beside those of gas."

Mr. Martin goes at length into the details of the cost of generating and compressing the gas at the mines, and the problem of using it, first, to transmit power directly, by means of compressed-air motors, and secondly, by supplying a smokeless fuel, of maximum efficiency, either for power generation or heating. The general result of his computations is to show that such a gas might be delivered into the gas-holders for a cost of about 7d. per thousand cubic feet, and sold to the consumer for about one shilling.

"Turning now to the incidental consequences of gas transmission, and giving due preference to the fog question, the general supercession of coal by gas would put an end, once for all, to the smoke nuisance, and the abnormal blackness and persistence of the London fog would become a memory of the past. Although for the sake of definiteness, I have hitherto dealt with the matter solely in its relation to London, there is no reason why gas should not be piped in the same way to every city and town in the kingdom. To inland towns indeed, which pay 18s. or 19s. for their gas coal, cheap gas would be an even greater boon than to London, with its sea-borne supply. Nor need the benefits of cheap gas be confined to the towns, for there is no reason why the trunk mains should not be tapped at any desired point along the route. The cause of industrial decentralisation could be given no greater stimulus than it would receive from the provision of light, heat and power at a minimum cost along every foot of the pipe-lines from the collieries to the metropolis.

ECONOMICAL GENERATION OF POWER.

A COMPARISON OF THE HIGH EFFICIENCY OF GAS POWER WITH OTHER SOURCES OF MECHANICAL ENERGY.

E. R. Knowles—Electrical Review.

NEARLY a hundred years ago the work of the engineer was defined as consisting in the direction of the great sources of power in Nature to the use and convenience of man, and only a short time before his death the late George S. Morison expressed himself as of the belief that the great work of the engineer consisted in the manufacture of power.

In a paper published in a recent issue of the *Electrical Review* Mr. E. R. Knowles reviews the growth of the internal-combustion motor, and under the title of the "coming power" he shows that in many instances it is more economical to employ the gas engine than it is to harness the apparently cheaper power of the natural waterfall.

Steam power, as may readily be shown, suffers in efficiency by reason of the imperfect thermodynamic cycles to which we are limited in its use; besides which the successive transformations leave opportunities for losses which are fatal to the accomplishment of the highest results.

"The reason for the enormous loss lies in the large number of transformations and apparatus which the thermal units have to pass through before the desired result is obtained, and in the system itself, which is inherently inefficient. The combustion in the furnace, the radiations from the boiler, piping, auxiliary apparatus and engine, the waste gases in the chimney, the waste steam in the exhaust, the condenser and other auxiliaries all claim their quota, and so large a one that very little is left for useful effect. The truth is that the source of power is, so to speak, too far removed from the point of application.

"The nearer to the point of application the fuel can be utilized and the greater the number of these intermediate transformations that can be eliminated, the less will be the losses, and consequently the greater will be the useful effect.

"In order to accomplish this desired result the effort has been made, and quite successfully, to burn the fuel directly at or in the engine and thus eliminate all of the intermediate steps and utilize to the utmost the full value of the thermal units in the fuel."

The use of the gas engine does not mean that the manufacturer is obliged to depend upon outside sources for the gaseous fuel for the engine upon which he relies for his power. On the contrary, it can be shown that it is easier, cheaper, and more convenient for him to manufacture his own power gas than for him to generate steam in a boiler for use in an engine of one-half the efficiency. This fact being accepted, the real advantages of the power-gas plant remain to be fully understood, and Mr. Knowles sets forth these advantages in a most convincing manner.

"In the first place the gas engine producer system is universally adaptable because it can utilize any form of fuel material; it can be installed at any point where fuel material and water can be obtained, and it is not dependent on any form of manufactured commodity for its maintenance and operation.

"Next it is cheapest because the initial cost of the installation is low; the cost of building room or floor space occupied is a minimum; only a small fuel storage is required; a small amount of water is needed, and this water can be used over and over again; the lowest grades of fuel materials can be employed, and the thermal value of the fuel material utilized to the utmost; the fuel can be burned exactly at the point of power generation, and a very large proportion of the thermal losses due to transformations be prevented; the cost of maintenance and repairs is reduced to a minimum and the stand-by losses are low.

"Then the producer gas system is simple and compact because the apparatus is self-contained, the space occupied is small, the erection and arrangement of the system is not complicated and there are few parts, no chimney or high-pressure steam boilers are necessary, the piping system is simple and little auxiliary apparatus is required.

"The system is efficient also because of the uniform quality of the fuel used; no fuel is wasted; the fuel is consumed in proportion to the load; perfect combustion of the fuel is attained at the point of power production; a very high per cent of the thermal units in the fuel is utilized in the production of power; the same thermal efficiency can be had in small as in large installations; fuel storage in the most compact and valuable form can be had without any loss of energy in the fuel stored, and the thermal losses in transmission in the system are reduced to a minimum.

"It is safe because there is no high-pressure steam boiler required, no high pressure in the piping, no danger from fire or explosion, it can be started and stopped instantly and there is perfect and automatic control of the system.

"It is sanitary because no smoke or deleterious vapors are given off, and the installation is clean, unobtrusive and not a nuisance in the neighborhood.

"Its repairs and maintenance are low because the installation is simple and has few parts; there is no high pressure in the system and no leaky joints, valves, etc., to be made good; the standby losses and wear and tear are reduced to a minimum; no licensed engineer or firemen are required, and no skilled labor is necessary.

"The attendance and attention required is small because the fuel and ash is centralized, all being handled at one point; the installation is always ready to operate, is automatic in operation; there are no delays for cleaning or starting fires or getting up steam, and the system can be operated continuously on long runs without injury, breakdown or adjustment."

Even where hydraulic power is available, Mr. Knowles shows that gas power can compete with it successfully. In a tabulated statement of the costs of power from various sources it appears that gas power ranges from $16 to $13 per horse-power per year, when producer or natural gas is used; while steam power costs about $40 and hydraulic power $29 per year per horse-power. In nearly every case the development of a hydro-electric plant involves the investment of a large amount of capital and the interest charges on the investment on the plant render water power more expensive in most cases than gas power, all other things being equal.

It is not claimed that gas power is free from losses, but it can be shown that the losses in a producer gas plant, and the heavy interest charges of a fully developed hydraulic power plant, when fairly compared, will show a large margin in favor of the combustion engine as a source of motive power.

"Doubtless, as time passes, still further improvements will be made in the gas system, and means will be found whereby the large percentage of waste, which still exists in this system, may be utilized for heating purposes and this objection finally removed.

"Finally, while the gas engine producer system is still far from the desired ideal system, nevertheless the great gains in efficiency of lowering the cost production shown by this system and its many advantages are such that with its advent the gas engine has made such rapid strides as a prime mover, and its adoption to power generation has given so much satisfaction not only from an economical point of view, but also for continuous and hard service, that it bids fair to revolutionize all present methods of power production and to become the legitimate successor of the steam engine and steam system."

RAILWAY EDUCATION.

POSSIBILITIES IN THE APPLICATION OF COLLEGE METHODS TO THE TRAINING OF RAILWAY EMPLOYEES.

Professor E. R. Dewsnup, St. Louis Railway Club.

TECHNICAL and scientific training has been provided in nearly all modern colleges for various departments of applied science, but there appears to be a demand for a still higher degree of specialization than has yet been attained. In a paper read before the St. Louis Railway Club, Professor E. R. Dewsnup, of the University of Chicago, discussed the desirability of providing a college for instruction in the different departments of railroad work, as distinguished from the engineering operations for which provision is already made in the regular engineering courses of many existing institutions.

"The number of persons engaged in engineering, in architecture, or in educational work falls far below the number at work in the transportation industry, and yet there has been but little effort to provide technical training for the latter. As a part result of this the railways are finding themselves today in lack of a sufficient number of men qualified to occupy, with dignity and with success, the positions of initial responsibility; men who know how to do the right thing at the right time, who show initiative and originality when thrown back upon their own resources, who possess not merely physical or brute obstinacy but especially that inflexible mental determination and persistency arising from the realization of the trained mind as to the relation of the individual worker to the collective working. It may be that careful professional training will be of considerable benefit to those destined to attain to the seats of power in the transportation industry; I am inclined to think that it will. The conducting of modern transportation is becoming constantly more and more complex; the day of happy-go-lucky, rule of thumb railroading, while not entirely gone, will soon be but a shadow of the past. There is no industry at the moment which demands keener intellect, shrewder wit, and better trained comprehension; no industry in which the failure of these qualities in its officers and, to no small extent, in its men, would be more disastrous to the general interests of the country. The necessity for, and demand for, an adequate supply of these qualities is increasing with the extension of the industry. In sheer self-defense, even from a dividend point of view, the railways of this country will have to pay more attention than they have ever done before to the improvement of the quality of the men they take into their employment. For their own interests, they must stimulate a steady flow of the brightest minds of each rising generation into their service, so that they may have ample choice of selection in filling up the lieutenancies and corporalships, some of those appointed to which, in turn, will qualify for responsibility as captains and colonels, and, maybe, even as generals of the railway army. There are all varieties of transportation problems, but, without doubt, the most difficult one of all is that of securing competent and trustworthy service."

The railway problems demanding special training relate to two departments of work, the first covering a regular course in transportation problems, bearing the same relation to the profession of railroading as the law school or the medical college does to the profession to which it relates. This branch relates to the provision of new men for the coming work of the railroads. There are, however, a great number of men already in service for whom technical education should be provided, and this naturally requires a different treatment.

"The railway companies, as a first and great step, should co-operate in founding, in some great railroad center such as Chicago, a railway college. The task of establishing the college should not be left to the railways centering in Chicago. The companies of the north, east, south and west will secure no less benefit from the realization of the project than the first named. I believe that the college should be placed in acadamic relation with the University of Chicago, because the broadening influence of a great university would be a good thing to have environing its students.

"One distinctive feature of this college should be the arrangement of the work of its members. The students should follow their classes from the beginning of October until the middle of June, and from that time until the middle of September should be placed out on the railroads at a small salary to learn the practical details of the business. They could be used to fill in the odd vacancies (which occur during every part of the year), and, even if they did not accomplish much, they would probably earn the small salary assigned. The combination, in each year of college life, of the theory of the class with the practice of the road would be beneficial both mentally and morally to the student. Any inclination to the swelled head acquired in the class room, would be knocked out of him most effectually by his associates in employment. During the whole period of the three months, he would be required to submit weekly reports as to the work he was doing.

The question of admission requirements is discussed by Professor Dewsnup, and he advocates the inclusion of a suitable preparatory course in the various high schools, this preparatory training covering the broad general foundation upon which the special course in railroading may be effectively reared.

"The courses of the railway college should provide training on five different sides, mechanical engineering, civil engineering, electrical engineering, commercial and operating, all with distinct reference, of course, to railroad work. To effect this the college should be in close touch with the engineering department of the university, so that courses common to railroad and general engineering should not need to be handled in the railway college, only those courses coming under its direct charge which bear a distinctly railroad aspect—for instance railway construction, maintenance of way, locomotive construction, locomotive tests and so forth."

Naturally the development of such a college as that suggested by Professor Dewsnup would make heavy demands for its financial support, but its value to the railways would be so great that such support ought to be forthcoming readily, both in the form of equipment and endowment.

"A difficulty of more importance than the financial one, though still but temporary, is that of securing suitable instructors. We need men of the highest and broadest mental training, keen in investigation, sympathetic in teaching, men who possess the most desirable academic qualities and qualifications, and at the same time have the practical instinct. We see no other opportunity but to train our own instructors and this we are proposing to do by taking able university graduates of suitable preparation, placing them for twelve months or so out on the road, a month here, three months there and so on, engaging in the practical side of the subjects in which they are specializing, studying the different methods in use and their relative values, consulting with and being advised by railway men of all grades and opinions. Furthermore, not only will they do this before engaging in teaching, but as instructors of the college, they will be expected to keep in touch with movements, in their respective departments, on the railways.

"It has been suggested that the railway college should be largely staffed by railway men. Where suitable men of actual road or office experience, efficient teachers and capable of real research work, in short, likely to do credit to the college, could be obtained, such could be made good use of. But the ex-railway man who has "resigned" because of incapacity, we do not want; the ex-railway man who has been worked out, we do not want; the ex-railway man who is looking for a kind of retiring allowance in the shape of a nice easy job, we do not want. The railway man of trained mind, high capacity and wide experience, possessing undoubted powers of discipline and exposition, associated with a strong personality, we do want, but we could not get him for the railways need this type of man for their own service, and are able to pay him anywhere from three to ten times as much salary as we could give him. A careful study of the question has convinced me that the policy of training our own instructors, securing them before they have the opportunity of making high salaries, men who combine the practical instinct with power of exposition, who possess love for research and are disposed toward teaching, is not merely the only feasible plan, but, except in special instances, the most desirable one."

GAS ENGINES FOR SHIP PROPULSION.

SPECIAL PROBLEMS IN PRODUCER AND ENGINE DESIGN TO ADAPT THE INTERNAL-COMBUSTION MOTOR TO MARINE SERVICE.

J. E. Thornycroft—Institution of Naval Architecture.

IN view of the high efficiency which has been attained by internal combustion motors for stationary service it was to be expected that gas engines should be applied to marine propulsion, and we have recorded from time to time in these columns the efforts which have been made to accomplish this desirable end. A very complete review of what has been done in this direction is given in a paper presented before the recent meeting of the Institution of Naval Architects by Mr. J. E. Thornycroft, and some abstract of this paper will serve to show the nature and extent of the difficulties which have been encountered and which are being overcome in this department of marine engineering.

Mr. Thornycroft calls attention to the fact that conditions afloat are very different from those obtaining in a land plant, and in order to make these differences clear he discusses some of the general features of such gas-power plants as have been found practicable on shipboard.

"The majority of small gas engines work on the 'Otto' cycle, which has the advantage of requiring no special gas or air pumps, and this is the only type of engine that has been as yet tried for marine work. The gas producer which is generally used for moderate powers works on what is known as the suction principle; that is to say, instead of the gas being generated by the combustion of fuel, by air and steam being forced through it under pressure, it is generated by the air being drawn through the producer, the whole of the apparatus working somewhat below atmospheric pressure. The advantage of this system is that neither a steam boiler working under pressure, nor a gas container for holding the gas is required, and the further very important advantage for marine work is that there is no danger from a leakage of gas from the producer; if leakage takes place, it is from the atmosphere into the producer itself.

"There are so many combined plants consisting of a gas engine working in conjunction with a suction producer at work for stationary purposes, that it might appear only very small alterations would be required in these plants to adapt them for marine propulsion; but, in addition to the great difference between almost all marine and land plants, viz., that of the quick and frequent variations of load which the smaller types of marine plants have to undergo, there are very many features which must be changed to adapt the gas engines and producer to boat work. In fact, it will be found that the principle of operation will be about the only thing which can be identical with the land plant, the details of the apparatus all having to be specially worked out for the new conditions. The producers for moderate-sized powers are usually worked with anthracite coal, and where vessels are to be used on fixed routes, and the same class of fuel can always be obtained, anthracite or coke will be found to be the most suitable for moderate powers, it being too difficult to make a satisfactory small plant to work with bituminous coal. For larger powers, and for vessels that have to take up fuel at different ports, the producer must be capable of dealing with coal, other than anthracite, which may be of a tarry or caking character.

"The design of the producer capable of successfully dealing with bituminous or caking coal is a much more difficult problem than the anthracite producer. There are, of course, very many large land installations of pressure producers working with bituminous coal, but the apparatus for extracting the tar and other by-products, as at present arranged, is far too cumbrous for marine work, and the marine producer to deal with this class of coal must be designed on entirely different lines, being arranged to consume the tar which is evaporated off from the coal in the first stages of its heating. This has been arranged in some producers by taking the gas off at a comparatively hot part of the fire, instead of at near the top of the new coal, as is usually the case with the anthracite producer; but there are plants now at work dealing successfully with bituminous caking coal, which are fed by an undertype stoker, so that the new coal is forced into the hottest part of the fire, and the tar which is driven out is at once burned. After the gas leaves the producer, it must be first cooled, and, as there will always be a certain amount of impurity, even when anthracite is used, it has to be thoroughly cleaned. This is usually done by passing the gas through a series of vessels where it is scrubbed by its passage through layers of coke over which water is running. It is frequently arranged that the cooling of the gas is effected by passing it over a water-containing vessel, which acts as a generator for the steam required by the producer; but there are disadvantages in this method where the producer is not working at a uniform load, as the steam will not be generated until the producer has been working some time, and will continue when the engine has been stopped, and when it is not required, and so cool the fire, causing the gas to be poor when the engine is again started, after the temporary stoppage has taken place. The large space occupied by the ordinary coke scrubbers prohibits their use for marine work, and to meet this difficulty Herr Capitaine has arranged his plant to clean the gas after it has been cooled by the introduction of a very fine spray of water, which mixes with the small particles of dust and other impurities in the gas, and forms a sort of fog; the gas in this stage is passed into a centrifugal apparatus having a peripheral speed of 160 feet a second, which throws out the moisture and impurities, leaving a clean dry gas to be drawn out by the engine."

The gas furnished by the suction producer is what may be termed a lean water-gas, consisting of about 25 per cent of carbon monoxide and 12 to 15 per cent of hydrogen, the balance being non-combustible, and since the combustion of the fuel is but partially effected in the producer, the principal combustion taking place in the engine itself, the producer occupies a very small space compared with the boilers for engines of equal power.

The advantages of the suction producer gas plant in stationary installations being fully conceded, the important thing in connection with its application to marine purposes is to consider the practical difficulties inherent in its operation afloat.

"The one great disadvantage of the internal combustion engine is the necessity of setting the engine in motion before it will run automatically. For powers less than 200 horse-power, it is preferable to employ a reversing gear, keeping the engine always running in the same direction, or to use a reversing propeller. Compressed air is being employed for starting up large engines, and when once the engine is fitted in this way, the valve gear for running the engine in either direction does not amount to very much. For moderate powers, a single-acting engine with a trunk piston is found most convenient, as the piston does not require to be water-cooled, until one as much as about 2 feet in diameter is employed. A single cylinder of 20 inches diameter and 2 feet stroke, running at 120 revolutions per minute, will give about 100 horse-power, taking the average working pressure at about 80, which is less than the figure often obtained. The same sized cylinder, working as a double-acting cylinder, would, of course, double the horse-power; but, besides the additional valves, which must be an exact duplicate of those required for a single-acting engine, there is the complication of the water-cooled piston and rod. This at first sight will appear somewhat serious to the marine engineer; but when the very large number of engines of this design which are working on land are considered—the regularity with which they are run, and the little attention they require—it will be agreed that there does not seem any reason why they should not meet with success at sea. For small plants of from 100 to 200 horse-power, a small auxiliary internal combustion motor, driven by oil or some other fuel, is found most convenient for blowing up the producer, for starting it, and also for starting the main engine. For larger powers fitted to vessels where steam capstans and steering gear are fitted, it is thought that the best plan will be to employ an auxiliary boiler, which can be heated by the gas when the whole plant is at work, and can be used independently to drive the various auxiliary and starting engines when the producer is not alight."

Mr. Thornycroft gives in his paper a number of illustrations of details which have been introduced by Herr Capitaine in his practical experiments, and some of the accounts of actual performance show that the adaptation of the gas engine to marine propulsion has become an accomplished fact.. The early experiments were made with a small boat of 16 tons displacement, but with this small craft a run of ten hours was made at a speed of 10 knots, with a total fuel consumption of 412 pounds of anthracite. Later trials were made on a larger boat from Hamburg to Kiel and back, this boat being 44 feet 3 inches long by 10 feet 6 inches beam, with four-cylinder motor of 70 horse-power. For purposes of fuel comparison the gas propelled boat was accompanied by a steamboat, the Elfriede, of practically the same dimensions and powering. The results showed that the gas-propelled boat required 530 pounds of anthracite, while the steamer consumed 1,820 pounds of steam coal, an advantage of 1 to 3.44 in favor of the gas plant. Both boats made a speed of 8½ knots, and the results may be accepted as comparable.

On the Rhine there is running a barge of 200 tons displacement operated by a two-cylinder Deutz gas engine and producer, giving satisfactory service between Rotterdam and Cologne, while in England a trip has been made with a barge equipped with a two-cylinder Capitaine gas power plant through the English canals.

The general results of these experiments have been so encouraging that engines of 500 to 1,000 horse-power are now being constructed by Messrs. Beardmore & Co., and we may soon expect to see such machines installed in large sea-going vessels, to the great improvement in fuel consumption, as well as increase in available cargo space. Comparative plans for steam and gas power plants in a cargo steamer of 7,000 tons displacement show that with the gas power plant there is a gain of 13,000 cubic feet of cargo space.

THE MOTOR OMNIBUS IN LONDON.

A DISCUSSION OF THE RELATIVE FIELDS OF THE SELF-PROPELLED OMNIBUS AND THE ELECTRIC TRAMWAY.

E. Manville—Automobile Club.

IT is generally conceded that in most great cities the horse-drawn vehicle must be generally supplanted by some form of mechanically propelled apparatus. In the great cities of Europe, and especially in London, the omnibus has held the field so long and so successfully, that when any change appeared necessary it was most natural that it should take the form of the new power applied to the old vehicle. In the United States, however, the omnibus was long ago supplanted by the horse-drawn tram-car, and this in turn was succeeded by the cable traction system and then by the electric trolley car, so that the two systems have grown up, not exactly side by side, but at least contemporaneously. There has now arisen, in London some difference of opinion as to whether the motor-omnibus is the thing, or whether, in abandoning the horse, the change should not have been made directly to the electric tramway system. In a paper presented recently before the Automobile Club by Mr. E. Manville the relative advantages of both systems are set forth, and we make some abstracts from this discussion, setting forth both sides of the question.

Mr. Manville sums up the advantages and disadvantages of both systems with an evident desire to be impartial, his opinions being as follows:

For the motor-omnibus, there is a probable greater speed from point to point, owing to the freedom of movement upon the road, the ability to vary the route from one road to another, the capacity to draw up by the pavement for passengers, the freedom from rails in the road, and the non-interference with other vehicles. Its disadvantages are its high cost of operation, its noise, smell, vibration, and general danger to other vehicles, together with its unreliability.

The electric tramway, on the other hand, has the lowest known cost of operation, comfort, cleanliness, and good lighting, together with reliability, and absence from danger. Its disadvantages, on the contrary, lie in the fact that it is confined to its rails, compelling passengers to cross to the middle of the road to enter or leave the cars, and the obstruction which it offers to other vehicles in narrow streets and roads.

"It cannot be denied that, amongst the disadvantages of the motor 'bus, there are some which are of the very first importance. I refer particularly to such items as the danger of side slip, the prevalence of which is so well known that it requires no further comment from me; danger of fire is one that has already asserted itself on several occasions, and though so far it has not led to serious accidents, as in the case of side-slip, it obviously may do so, owing to the necessity of carrying about large quantities of highly inflammable motor spirit. The first of these serious disadvantages is entirely absent from the electric tramcar, and the second one, although not entirely absent, cannot, on the rare instances when it occurs, lead to anything in the shape of danger to the public. It cannot, on the other hand, be denied but that the tramcar, when run in very narrow roads, leads to obstruction of other vehicles wishing to stop by the roadside; also the tramcars themselves having to keep to fixed lines, are delayed by other traffic interfering with their progression. As counterbalancing the installation of rails in the roadway may be mentioned the great improvement in the paving of many roads along which tramways run. It is common knowledge to all of us that the roads leading out from the metropolis and from other cities and towns in the kingdom have been kept in a most disreputable state of repair, owing to the inability of the local authorities to spend a sufficient sum on their unkeep outside of the centers. The principle which has been instituted in enforcing good paving for a portion of a road, as a penalty to be paid for the installation of the tramway system, has very largely benefited other users of the road in this direction, and it must be recollected that the tramway itself derives no advantage from the paving which it has to instal and maintain, the benefit of which accrues entirely to the other users of the road.

"Reviewing then, impartially the statements set forth above, I think it must be conceded that the balance of advantages, both to the traveling and non-traveling public, pertain to the tramway system rather than to the motor 'buses.

"If motor 'buses are started in competition with tramways already existing, or if tramways are started under suitable conditions in towns where motor 'buses already exist, it is certain that the motor 'bus, if worked will cease to exist."

So far as the relative costs of the two systems are concerned, Mr. Manville makes up two balance sheets, one taken from the operations of the Leicester Corporation Tramways, and the other from estimates especially prepared from data on the operation of motor omnibuses in London. The tramway sheet shows that the average receipt per car mile was 7.866d, and the total cost of operation, repairs and maintenance 4.583d.

In the case of the motor-omnibus system, the costs per car mile work out as high as 10.51d, while the income shows only 7.842d, or a net loss of nearly 30 per cent.

"From this it is evident that such a system run by motor omnibuses under prevailing conditions could only be a financial failure, but it must be borne in mind, whatever the academical opinions of promoters of motor omnibus enterprises may be, that it is almost certain no extensive system of such vehicles would be permitted within a town without heavy contributions in some form or other towards the paving of the streets, and, in that case, still further capital and renewal charges would have to be made.

"These two comparative balance-sheets take us a step further, since they enable me to construct a curve showing where, from the financial point of view, the costs of motor omnibus traction and of electric tramway traction become equal, and, following it on, where motor 'bus traction becomes more economical than electric tramway traction.

"The amount invested in the permanent way and overhead equipment of an electric tramway system is practically constant per mile, whatever the service of cars might be upon it, and, therefore, the interest on this portion of the capital must be divided amongst the car-miles run, whatever they may be, so that the smaller the service the greater the burden of these capital charges.

"In every city or town in which electric tramways exist there are numbers of routes in which the service that could be profitably maintained is less than that shown upon the diagram, and electrical tramway undertakings are beginning to use, and doubtless will exhibit an increasing tendency to use, motor 'buses.

"In all the smaller towns where the minimum profitable tramway service cannot be maintained, motor omnibuses will have the entire field to themselves. So also will be the case in those numerous instances where towns not directly lying upon the railways require communication with these.

"Of the crowded centers of population London offers a unique field for the use of the motor 'bus. There the tramway system must be carried on under disadvantageous circumstances: First, because it cannot reach the centers of the City, and, therefore, provide through communication; secondly, since overhead wires are not permitted, vastly increased capital costs are experienced in the construction of the electric tramways system.

"On the other hand, the vitality of the electric tramway system in London is well shown, since, although it is handicapped so materially by not being able to reach the center of the city, it nevertheless carries enormous numbers of the public, and has proved itself a most comfortable, profitable and convenient method of traveling."

PROBLEMS OF HIGHWAY MAINTENANCE.

METHODS OF DRAINING EARTH ROADS IN THE PRAIRIE SOIL OF THE MIDDLE WESTERN UNITED STATES.

Ira O. Baker—Engineering Record.

WITH the growing interest in the construction of good roads in the United States everything which relates to the maintenance and improvement of highways demands attention, and hence the bulletin upon the drainage of earth roads, issued by Professor Ira O. Baker, of the University of Illinois, and published in a recent issue of the *Engineering Record* forms a subject for comment and review.

Of course the great highways constructed by the best engineering ability, and maintained by sufficient expenditure have includen in their design such suitable drainage systems as may be indicated by local conditions. In the middle western states, however, there are many earth roads, built at moderate expense, in prairie soil, which need only proper drainage to remove much of the disability under which they labor, especially in the thawing periods after the winter freezing temperature. It is to this department of road work that the bulletin of Professor Baker is directed, although much of its matter will be found valuable and appropriate for use elsewhere.

"The best and cheapest method of securing underdrainage is to lay a line of porous or farm tile 3 or 4 ft. deep on one or both sides of the roadway. It should be uniformly burned, straight, round in cross-section, smooth inside and have the ends cut off square. Before the introduction of tile for agricultural drainage, it was customary to secure underdrainage by digging a trench and depositing in the bottom of it logs or bundles of brush, or a layer of broken stone; or a channel for the water was formed by setting a line of stone on each side of the trench and joining the two with a third line resting on these two. Apparently it is still the practice in some localities to use such substitutes for ordinary drain tile. Tiles are better, since they are more easily laid and are less liable to get clogged. Tiles are cheaper in first cost, even when shipped considerable distances by rail, than any reasonably good substitute, and the drains are much more durable.

"Tiles are laid simply with their ends in contact, care being taken to turn them until the ends fit reasonably close. In some localities there is apparently fear that the tile will become stopped by fine particles of soil entering at the joints, and consequently it is specified that the joint shall be covered with tarred paper or something of the sort; but in the Mississippi valley, where immense quantities have been laid, no such difficulty has been encountered. With a very slight fall or even no fall at all, tiles will keep clean if a free outlet is provided and they are not obstructed by roots or trees."

In scientific road making much attention is given to the slope of drains and the computation of the amount of water they can remove. In such work as that under consideration no great degree of refinement is demanded, and the principal thing is to be assured that there is sufficient slope, there being no danger of the grade of the tile being too great. The common practice in farm drainage, however, calls for steeper slopes than are considered necessary by Professor Baker, he being of the opinion that the minimum grade to give good service is ½ inch in 100 feet, while it is undesirable to have a steeper slope than 2 inches in 100 feet.

"The traveled portion of an important road is usually not more than 50 ft. wide, and therefore a single line of tile 2½ to 3 ft. below the bottom of the side ditch, if of adequate size, will give nearly perfect drainage; and a second line will not greatly improve it. If a second line of tile is laid on the other side of the road it will drain only a comparatively small portion not reached by the first line. A single line well below the surface is better than two shallow ones.

"It is generally conceded that for agricultural drainage it is sufficient to place the lines of tile 100 ft. apart, provided they are of reasonable size and at sufficient depth. A tile will give agricultural drainage 50 ft. on either side of it; that is, a tile under only one side ditch will give agricultural drainage of the traveled way. More thorough drainage is required for agricultural than for road purposes, since when damp most soils will pack, which is harmful to agricultural land but beneficial to a road.

"The above seems to prove that one line of tile, if of proper size and at sufficient depth, will afford sufficient drainage for road purposes; but nevertheless it is claimed by competent authorities that two lines are sometimes required. In some localities a stratum of hard-pan near the surface makes it necessary to lay the tile so shallow that two lines are really required; and sometimes the tile is so small or so poorly laid that one line is insufficient.

"Some authorities recommend a line of tile under the middle of the traveled portion. A tile under the middle of the road is a little more effective than one at the same level under the side ditch; but the former is considerably more expensive to lay, since it necessitates more digging—whether the tile is laid before or after the road is graded. With the same depth of digging, a tile under the side ditch is more effective than one under the center of the road. Further, if the tile is under the center, there is liability of the settling of the soil in the trench, which will make a depression and probably a mud hole; and if the tile becomes stopped it is expensive to dig it up, and the doing so interferes with traffic. Finally, if the road is ever graveled or macadamized, the disadvantage of having the tile drain under the center of the road is materially increased."

The question of the provision of side ditches is fully considered by Professor Baker, these acting to carry off the surface water, and also to intercept the water which might otherwise flow from the side hills upon the road. One of the most important things to be observed about such ditches is to provide suitable outlets into available streams or other sources of discharge, since no good can be obtained from ditches which merely collect the water and hold it until it evaporates.

"If it can be prevented, no attempt should be made to carry water long distances in side ditches, for large bodies of water are hard to handle, and are liable to become very destructive. Side ditches should discharge frequently into natural water courses, though to compass this it may in some cases be necessary to carry the water from the high side to the low side of the road. This is sometimes done by digging a gutter or by building a dam diagonally across the road, but both are very objectionable. A better way is to lay a tile or put in a culvert, the amount of water determining which shall be done.

"It is sometimes necessary to carry water a considerable distance in the side ditches, as, for example, when the road is in excavation. This requires deep ditches, which are undesirable and dangerous; and if the grade is considerable, the ditches wash rapidly. In such cases it is wise to lay in a line of tile under the side ditch, and turn the water from the surface ditch into the tile at intervals. This can be accomplished readily by inserting in the line of porous tile a Y section of vitrified sewer pipe, with the short arm opening up hill. Of course, the short arm, i. e., the vertical arm, need not be as large as the body. If necessary two or three lengths of porous tile may be added at the upper end of the Y to make connection with the bottom of the open ditch. Earth, sods or stones can be piled around the upper end of the tile to make a dam and hold the tile in place.

"As a rule, side ditches will not have too much fall, but sometimes a ditch straight down a hill will have so much fall as to wash rapidly, in which case it is an advantage to put in an obstruction of stone or brush. In extreme cases the bottom of the ditch is paved with stones.

"The surface drainage of a road is provided for by crowning the traveled way and keeping it smooth. The making of the road crowning in the beginning is a matter of construction, and the keeping of the surface smooth is a question of maintenance. It should be remembered that water upon the surface of the road cannot be carried away by the underdrains until after it has penetrated and softened the road surface.

"The slope from the center to the side should be enough to carry the water freely and quickly to the side ditch; and if the surface is kept free from ruts and holes, less crown will suffice than if no attention is given to keeping the surface smooth. If there is not enough crown the water cannot easily reach the side ditches, and the road soon becomes water-soaked.

"On the other hand, the crown may be too great. If the side slopes are so steep that traffic keeps continually in the middle, the road will be worn hollow and retain the water instead of shedding it promptly to the side ditches. With the ordinary method of caring for earth roads, more water stands on a very convex road than on a flatter one. If the crown is too great, it is difficult for vehicles to turn out in passing each other. Again, if the earth is piled too high in the middle, the side slopes will be washed into the side ditches, which not only damages the road, but also fills up the ditches."

After proper construction and drainage details have been provided for a road, it is essential that these elements should be properly cared for, and under this Professor Baker discusses the question of maintenance.

"Proper maintenance is as important as good construction. A distinction should be made between maintenance and repairing. The former keeps the road always in good condition; the latter makes it so only occasionally. A defect which could be remedied in the beginning with a shovelful of earth or a minute's time, if neglected may require a wagon load of earth or an hour's time, besides being in the meantime an annoyance or a danger to traffic. The better the state in which the road is kept, the less are the injuries to it by ordinary traffic and the weather. Water is the natural enemy of good earth roads. The chief object of maintenance should be to keep the surface smooth and properly crowned so that rain water will be shed promptly into the side ditches. These should be kept open so that the water may be carried entirely away from the road."

WATER-WHEEL GOVERNORS.

THE GRADUAL DEVELOPMENT OF ACCURATE AND SENSITIVE APPLIANCES FOR THE SPEED REGULATION OF HYDRAULIC MOTORS.

American Society of Mechanical Engineers.

At the recent meeting at Chattanooga of the American Society of Mechanical Engineers it had been arranged that a special discussion should be held upon the subject of the speed regulation of hydraulic motors. The result was a collection of notable papers by some of the ablest specialists in the United States in this department of engineering, relating directly and indirectly to the question.

The subject of the precise regulation of the speed of hydraulic motors has become of much more importance than formerly, and since the development of the hydro-electric power station, the turbine wheel has been called upon to drive the dynamo with a uniformity of rotative speed of a much higher degree than was necessary for ordinary mill machinery. Like many other mechanical problems of difficulty the demand has met with a full response, and today the apparatus for the speed-control of hydraulic motors has attained a degree of perfection beyond even the exacting demands of the electrician.

Of the papers presented at the Chattanooga meeting, two, by Messrs. Mark A. Replogle, and John Sturgess, related to appliances for governing hydraulic turbines, while Mr. George J. Henry discussed the speed regulation of high-pressure waterwheels of the Pelton type. Another paper of importance was contributed by Mr. George A. Buvinger upon the related question of the design of the turbine itself, with its gates and operative mechanism, this naturally having a marked influence upon the effectiveness of the regulating mechanism. To these was appended a paper by Mr. W. O. Webber upon the general subject of efficiency tests of turbine waterwheels, the whole group forming a most valuable contribution to an important department of applied science.

It is manifestly impracticable to give more than a general review of these papers within the limited space here available, and the original communications should be consulted by every engineer who desires to be informed of the latest practice in turbine governing. Some of the more salient points may be brought out, however, and the trend of the discussion indicated.

The paper of Mr. Replogle gives a brief history of his own practical studies in the problem of turbine-governor design, covering more than fifteen years of effort with a variety of designs, and follows with a description of the latest type of governor resulting from the united work of himself and Mr. Nathaniel Lombard, himself another laborer in this same field of research and invention.

Mr. Replogle shows that in order to secure accurate speed regulation of turbine wheels the mechanism must possess qualities which closely resemble what is called reason when exercised by living beings.

"A good water-wheel governor must be able to move the gates slowly or rapidly, as necessity requires. This discrimination savors of good judgment. A good governor must always stop operating before the speed has reached normal.

"In fact it ceases to operate at a speed that is farther from normal than that necessary to cause it to begin operating at the start. This is judgment. A good governor always ceases to operate before the speed has returned to normal; sometimes it ceases a shorter time before the speed is right; and again it ceases a longer time before the speed has exactly reached normal, but always just long enough ahead of time to allow the speed condition to be right after the inertia effects of the water, the new load conditions, and the new power conditions are balanced."

Mr. Replogle says that such conduct would be called reason if performed by a man, a horse, or a dog. We think he might have gone further and expressed doubt if any human governor ever exercised his executive functions in such a satisfactory manner for the regulation of human irregularities of conduct.

The perfected machine resulting from the combined labors of Messrs. Replogle and Lombard is purely mechanical in its action, and involves the use of a differential friction driving system constructed with a rotating spherical pulley acting between two concave leather-lined friction discs. The position of the spherical pulley with respect to the discs is controlled by a centrifugal governor, its position between the discs causing the pulley to be driven in the direction to open or close the gates as the case may be. The rotation of the pulley aso acts upon a screw on its own axis to restore it to the normal position, and there is thus a differential action which is self-correcting to a degree which effectually prevents all hunting or racing.

Passing to the paper of Mr. Henry we see the difficulties which are encountered in high-pressure water-power plants from the velocity of flow. It is, of course, practicable to vary the amount of water impinging upon a wheel by deflecting the nozzle to one side, and thus avoid any change in the volume or velocity of the jet, and in cases in which a required volume of water must be delivered below the wheel for irrigation purposes such a method may be found desirable even though it is wasteful of energy. By the use of a needle in the axis of the jet the flow of water through the nozzle may be varied without making objectionable changes in the form of the jet of water itself, and in practice the best results are obtained by a combination of the deflecting nozzle and the needle.

The papers of Mr. Sturgess and Mr. Buvinger treat of the important questions of general design as affecting speed regulation, showing the extent to which the difficult work of the governing mechanism may be aided by the designer of the entire plant.

The whole series of papers demand the attention of hydraulic and power-plant engineers everywhere, and the manner in which the subject is thus treated by a body of expert specialists is a very definite endorsement of the policy of the Society in arranging for such discussions as characteristic features of its meetings.

THE DEVELOPMENT OF THE PORTABLE STEAM ENGINE.

ECONOMICAL PERFORMANCES RESULTING FROM THE APPLICATION OF COMPOUNDING AND SUPERHEATING TO ENGINES AND BOILERS OF THE PORTABLE TYPE.

Karl Heilmann—Verein Deutscher Ingenieure

FORMERLY the portable steam engine was considered much in the same class as other agricultural machinery. A horizontal slide-valve engine, bolted to the top of a locomotive boiler, the whole mounted on wheels to be drawn from place to place by animal power, it received but little attention from the engineer by whom it was built, and less by the laborers by whom it was operated.

In England, where the portable steam engine had its origin, the performance has been materially improved as a result of the various competitive trials conducted by the Royal Agricultural Society, but nevertheless such machines have hardly been considered as serious competitors of the more elaborate forms of stationary steam engine, so far as economical performance is concerned.

In Germany, however, the continued efforts of Messrs. Wolf, of Magdeburg, have resulted in the development of a semi-portable engine and boiler, following in general the earlier lines, so far as the use of a horizontal engine on top of a locomotive boiler are concerned, but including the latest developments in compounding and superheating to such an extent as to yield a degree of efficiency equalled only by the very highest types of stationary engines. In a series of papers in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure,* Herr Karl Heilmann discusses the gradual evolution of the portable engine, from its beginning in England in 1840 down to the latest form of the Wolf compound machine, and some abstract of these papers will be found of practical interest.

The earliest Wolf engine resembled very closely its British prototype, being a simple slide-valve engine of eight horse power at 120 revolutions; the locomotive boiler carrying a pressure of 6 atmospheres, this being fairly high for that date, 1862. This machine now rests in the new technical museum in Munich as a mechanical curiosity.

The gradual development of the portable engine included the use of higher steam pressures and a separate cut-off valve and eccentric, and by 1880 machines of this type showed, in official trials a steam consumption of 14.6 kilogrammes of steam, and 2.08 kilogrammes of coal per horse-power-hour.

With the improvement in construction and in performance, came also increase in size, and this naturally led to the idea of compounding. The first compound engine made by Wolf in 1883 was of 48 horse-power, a cross compound machine, with Rider cut-off valves, giving an economy of 8.76 kilogrammes of steam, and 1.328 kilogrammes of coal per horse-power-hour. This was followed by several machines of the same type and various dimensions, these being the result of continual and scientific investigations, using steam pressures up to 10 atmospheres, and the results of the studies which were made with these engines showed that with saturated steam the following thermal performances were attainable: With the simple engine a horse power required 7,300 calories per hour; for the compound engine, exhausting into the atmosphere, 5,630 calories; and for the compound-condensing engine, 4,000 calories; the feed water being taken at zero Centigrade in all three cases.

For further improvement it appeared that recourse must be had to superheating, and it is in this direction that the latest types of the portable engine have shown great susceptibility to development. It must be understood that by this time the portable engine, or at least, the semi-portable type self-contained, but not mounted on wheels, was beginning to find acceptance for stationary and manufacturing purposes, in competition with the regular stationary mill engine.

Experiments with independent superheaters gave very encouraging results, and in consequence the steam generator of the Wolf machine was redesigned to include superheating apparatus. The form of superheater selected was that of a spiral coil of pipe placed in the smoke box of the locomotive boiler, this receiving the direct heat of the gases of combustion after passing through the tubes of the boiler and permitting of ready access for inspection and cleaning. With the design of the superheated steam engines every precaution was taken to prevent heat losses, the steam pipes being carried through the steam space of the boiler, the cylinders enclosed in the steam dome, and hence provided with the most effective steam jacketing, while the proportion of heating surface in the superheater was made such as to give about 100 degrees Centigrade superheat, with a boiler pressure of 12 atmospheres. These later engines, built in sizes from 150 to 220 horse-power, have shown economical performances equalled by but few stationary engines. Tests by such engineers as Professors Lewicki, Gutermuth, and Josse, upon different engines, and at various times, show that a brake horse-power is obtained with steam consumptions ranging 5.6 to 4.67 kilogrammes of steam per hour (12.32 to 9.97 pounds), and a coal consumption of 0.633 to 0.567 kilogrammes (1.34 to 1.25 pounds).

Herr Heilmann gives a comparative table showing the performances of other first-class steam engines of recent make as well as of steam turbines, and these figures are interesting.

Thus a tandem Sulzer compound engine gave a steam consumption of 5.67 kilogrammes per horse-power-hour, or 12.47 pounds; and a triple-expansion engine by the Görlitz Machine Works a consumption of 4.53 kilogrammes. The best performance shown for a steam turbine is that of a Brown-Boveri-Parsons machine, which gave a brake horse-power with a steam consumption of 4.85 kilogrammes per hour, or 10.67 pounds; while the Zoelly turbine gave 5.78 kilogrammes, and the Parsons, among others, 6.4 kilogrammes.

There are several reasons which account for the excellent performance of the Wolf portable engines. Both engines and boilers are well designed and proportioned. The boiler, being internally fired is free from any losses due to air leakages, so common with brickwork settings, while the location of the superheater, directly in the smoke-box, enables the heat not abstracted in the boiler to be applied to the steam. A distinct advantage is the avoidance of long exposed steam mains between the superheater and the cylinder, the steam pipe passing directly to the engine without opportunity for any of those losses which, as Dr. Berner's experiments have shown are so apt to occurr in the transmission of highly superheated steam. The best results of the Wolf engines were obtained with steam superheated 150 to 170 degrees C. above the temperature of saturation, and the full benefit of this degree of superheat is very apt to be lost if there is any material distance between the engine and the superheater. The later Wolf engines also use an interheater between the two cylinders, this interheater also formed of a coil in the smoke-box of the boiler, an excellent and effective arrangement, but only practicable when the engine is so close to the boiler as to form practically one machine.

The results above detailed show how, by the careful application of scientific principles to design and construction, such an unpromising subject as the ordinary portable engine may be converted into a machine of the very highest thermal and commercial efficiency.

THE ENGINEERING INDEX

"THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE."

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Curves for Reinforced Arches. Daniel B. Luten. Gives illustrations, with explanation, of several methods of design and reinforcement. 1000 w. Eng Rec—April 14, 1906. No. 76317.

"Horseshoe" Concrete Arches. Daniel B. Luten. Illustrations with description of the construction of this type of arch as built on the Indiana railways. 1200 w. R R Gaz—April 20, 1906. No. 76151.

Special Design of Centers for Parabolic Concrete Arch Bridge, Washington, D. C. Shows the method of erection of the arch center of the 16th St. bridge in Washington, D. C. Ills. 600 w. Eng News—April 19, 1906. No. 76133.

The Computation of the Volume of Arches with Inclined Faces (Berechnung des Kubikinhalts von Gewölben mit Schiefem Stirnanzug). Alfred Wessely. Deriving formulas for the calculation of the cubic contents of masonry arches and vaults of semicircular shape with a slope or batter to the external faces. A number of cases are worked out. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—March 16, 1906. No. 76223 D.

Bascule.

New Type of Bascule Bridge. Enos Brown. Illustrates and describes a bridge of the Page bascule type, built at San Francisco. 700 w. Sci Am Sup—April 21, 1906. No. 76136.

Designs.

Bridges. Willis Whited considers points in bridge designing. General discussion follows. 4800 w. Pro Engrs Soc of W Penn—April, 1906. No. 76352 D.

Eye-Bars.

New Facts About Eye-Bars. Discussion of paper on this subject, by Theodore Cooper. Ills. 3800 w. Pro Am Soc of Civ Engrs—April, 1906—No. 76394 E.

Overloads.

Concerning the Investigation of Overloaded Bridges. William J. Watson. Discusses the great discrepancy between theory and observed results, and points concerning the design of new work and the investigation of old work. 3000 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76392 E.

Reinforced Concrete.

A Flat Span Reinforced Concrete Bridge at Memphis. A highway bridge of 100 ft, through span is illustrated and described. The cost was $17,500. 1100 w. Eng Rec—April, 1906. No. 75983.

Reinforced Concrete Arch Bridge at Peru, Indiana. Daniel B. Luten. Illustrates one of the longest reinforced-concrete bridges ever erected. It crosses the Wabash River with seven arches. 2500 w. Eng News—March 29, 1906. No. 75863.

Schuylkill.

Schuylkill River Bridge. Illustration and description of a bridge at Philadelphia on the Pennsylvania R. R. The approaches are masonry spans 60 ft. across with piers 70 ft. through, and the abutments of the steel structure are 25 ft. through. The steel span is a Pratt truss deck bridge. 600 w. Ry & Loc Engng—May, 1906. No. 76372 C.

Swing Bridge.

The Rodah Bridge. An illustrated description of the Rodah swing bridge at Cairo. It is built on seventeen piers, with fifty-five main girders. 600 w. Engr, Lond—April 6, 1906. No. 76084 A.

Viaduct.

Rebuilding the Rondout Viaduct. This viaduct on the West Shore R. R. is described and illustrated. The heavy traffic recently sent over the road, made it necessary to strengthen the structure, and the work is described. 4700 w. Eng Rec—April 7, 1906. No. 75981.

CONSTRUCTION.

Cofferdams.

Steel Piling Cofferdams for Bridge Piers. Illustrates and describes cofferdams used in building piers for a bridge near Chillicothe, Ohio. 1000 w. Eng Rec—April 21, 1906. No. 76326.

Columns.

Diagrams for the Strength of Steel and Wooden Columns. Louis Ross. Gives diagrams, illustrating their use by examples. 600 w. Eng News—April 26, 1906. No. 76340.

Concrete.

The Possibilities of Concrete Construction from the Standpoint of Utility and Art. William L. Price. Read before the Assn. of Am. Portland Cement Mfrs. Discusses the dangers and possibilities of this material. 1600 w. Sci Am Sup—April 28, 1906. No. 76382.

Fire Proofing.

Fire-Resisting Construction and the Ultimate Life of Mercantile Buildings: A Plea for Better Constructive Methods. J. K. Freitag. Comments on the justness of English criticism of American practice, as shown in a recent discussion of a paper by Reuben A. Denell. 3800 w. Eng News—April 26, 1906. No. 76342.

The Farwell, Ozmun, & Kirke Co., Warehouse at St. Paul. W. H. Dillon. Description of fireproof construction in reinforced concrete. 1800 w. Eng Rec—April 21, 1906. No. 76330.

Loading.

In Relation to Loading Long Structural Material. T. S. Kirk. Reviews the changes which have made the loading question much more difficult in recent years, and discusses briefly some of the questions. General discussion follows. 15500 w. Pro Ry Club of Pittsburgh—Jan. 26, 1906. No. 76386 C.

Reinforced Concrete.

A Garage of Reinforced Concrete. Illustrated description of a building in West 93d St., New York, designed as a public garage for the storage and care of automobiles. There are three floors and a basement. 800 w. Archts & Bldrs Mag—April, 1906. No. 75916 C.

Computations for Ceilings and Beams in Reinforced Concrete (Calcul des Hourdis en Béton Armé). P. Cafourier. Deriving simple formulas for the distribution of reinforcing rods for various loads and spans. 1500 w. Génie Civil—April 7, 1906. No. 76220 D.

Recent Developments in Reinforced Concrete Construction. M. M. Sloan. Comments on the causes that have led to the rapid advance of reinforced concrete, discussing details, elementary principles, advantages and limitations. Ills. 2800 w. Archts & Bldrs' Mag—April, 1906. Serial. 1st part. No. 75917 C.

Reinforced Concrete Sand Bins. Illustrated description of a cluster of sand-storage bins, built in New York City of reinforced concrete. 100 w. Eng Rec—April 21, 1906. No. 76327.

Reinforced Concrete Work at the New Railway Terminal Station at Atlanta, Ga. Illustrated detailed description of a terminal station where this material has been used in a variety of ways. Also editorial. 4500 w. Eng News—April 12, 1906. No. 76049.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. Continued discussion of paper on this subject by John S. Sewell. 8400 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76393 E.

The Reinforced Concrete Bath House Failure at Atlantic City, N. J. Photographs, with description of the causes which led to the failure. 600 w. Eng News—April 5, 1906. No. 75953.

See also Civil Engineering, Bridges.

Retaining Wall.

Plumbing a Leaning Retaining Wall and Bridge Abutment. Lindsay Duncan. Illustrates and describes work on a viaduct at Pueblo, Colo. 600 w. Eng News—April 5, 1906. No. 75951.

Roads.

Good Roads. Frank Soule. Points out benefits derived from good roads, considers some of the characteristics such roads should possess, and urges improvement of the roads in California. 3300 w. Cal Jour of Tech—Feb., 1906. No. 75958 C.

Roofs.

Difficult Reconstruction of a Church Roof. Describes the original design and shows how changes made in the building weakened the framework, and gives an illustrated description of difficult repairs, made without injuring the costly interior decorations. 2500 w. Eng Rec—March 31, 1906. No. 75884.

Steel Structures.

San Francisco Buildings after the Disaster. Reports favorably concerning the resistance of steel structures to earthquake and fire, and some plans for reconstruction. 3000 w. Ir Age—April 26, 1906. No. 76321.

Steelwork Details of the New Office Building of the New York Central R.R. Describes interesting details of the building under construction at Depew Place, New York City, where arrangements have been made for very heavy loads. 2500 w. Eng Rec—April 7, 1906. No. 75987.

Structural Steel Work in a New York Office Building. Illustrates and describes the construction of one of the tallest of steel-cage structures in New York City. 2200 w. Eng Rec—April 14, 1906. No. 76316.

Tunneling.

A New Method of Rock Tunneling Under City Streets. Frank Richards. Illustrates and describes the method of driving rock tunnel heading with drills and "Radialaxe" channelers. 1800 w. Eng News—April 5, 1906. No. 75948.

The New Bergen Hill Tunnel of the Lackawanna. J. H. Philips. Detailed description, with diagrams, of this new tunnel to relieve congestion at this point on the Lackawanna R. R. 1000 w. R R Gaz—April 6, 1906. No. 75954.

Underpinning.

Underpinning Old Walls with Steel Columns. Illustrates and describes the method of underpinning an old brick wall with double pipe columns in the course of erecting a tall office building in New York City. 1400 w. Eng Rec—March 31, 1906. No. 75886.

MATERIALS OF CONSTRUCTION.

Cement.

The Clinkering Curves of Portland Cement. Fred Vickery. Describes investigations made and gives results obtained. 1800 w. Cal Jour of Tech—Feb., 1906. No. 75959 C.

The New Kiln Firing Process at the Lawrence Cement Co.'s Siegfried Mill. Information concerning the new method introduced in this mill in Siegfried, Pa. Ills. 1000 w. Eng Rec—April 7, 1906. No. 75986.

Cement Burning.

The Gas Producer in the Manufacture of Cement (Der Generator in der Zementindustrie). C. Naske. A discussion of the heat balance in the cement kiln, with especial reference to gas firing. 2500 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76206 D.

Fire Brick.

Fire-Brick Work. R. P. King. Considers important points in the building of fire-resisting structures, particularly in reference to boiler setting. 2000 w. Am Mach—Vol. 29, No. 15. No. 76034.

Marble.

Marble in the Northwest. J. C. Rathbun. Introductory remarks on varieties of marble and the qualities that determine their value. Information concerning the deposits in the northwest, especially in Washington and Alaska. 2000 w. Min Wld—April 7, 1906. No. 75979.

MEASUREMENT.

Surveying.

Common Sources of Error in Field Work. A. M. Shaw. Gives sources of error and their suggested remedies. 700 w. Eng News—April 19, 1906. No. 76131.

Field Methods of Triangulation in the

Plains Country in Montana. John T. Stewart. Abstract of a paper read at the annual meeting of the Illinois Soc. of Engrs. & Survs. Describes the field methods of triangulation used in Montana in establishing geodetic positions for the control of a topographic survey. 5500 w. Eng News—April 12, 1906. No. 76050.

Surveying on the Farm. A. S. Kenyon. Explains the use of the miner's triangle, the water level, leveling operations, and boring rods. Ills. 1800 w. Sci Am Sup —April 28, 1906. No. 76383.

The Mayer and Wiesmann Theodolite (Tachéomètre A. Mayer et E Wiesmann). L. Fonjallaz. Illustrating and describing an improved transit-theodolite, especially adapted for tunnel work and used in connection with the work on the Simplon Tunnel. 2500 w. Bull Tech de la Suisse Romande—April 10, 1906. No. 76266 D.

MUNICIPAL.

Fire Loss.

The San Francisco Disaster: Earthquake and Fire Ruin in the Bay Counties of California. An account of this disaster, with map showing the approximate extent of the burned district. 4500 w. Eng News—April 26, 1906. No. 76343.

Fire Protection.

See Civil Engineering, Water Supply.

Pavements.

Vitrified Brick for Paving Purposes. Directions for laying brick pavements prepared from the experience of eminent engineers. 2500 w. Eng Rec—April 14, 1906. No. 76320.

Refuse.

Disposal of Municipal Refuse, and Rubbish Incineration. H. de B Parsons. Gives data on the subject of municipal refuse and describes the rubbish incinerating plant in Delancey Slip, Manhattan, with the adjoining electric lighting station, which utilizes the heat produced to light the Williamsburg Bridge. Ills. 6500 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76391 E.

Sewage.

Disposal Plants in the State of Wisconsin. John F. Icke. An illustrated article reviewing the plants and processes in use. The plant at Madison is fully described and reported. 11500 w. Wis Engr—March, 1906. No. 76094 D.

Report on Sewage Purification Experiments at Columbus, O. A summary review of the tests, as given by George A. Johnson, with editorial. 5000 w. Eng News—April 5, 1906. No. 75952.

The Johannesburg Municipal Sewage Scheme from a Bio-Chemical Point of View. W. C. C. Pakes sketches the proposed scheme and discusses it from the view of modern facts and theories. Considers it sound from both a sanitary and commercial point of view. Discussion. 7500 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1906. No. 76146 E.

Sewers.

Breakage in Sewer Conduits: Its Cause, Effect and Prevention. Alexander Potter. Read before the Sanitary Sec. of the Boston Soc. of Civ. Engrs. Gives facts bearing on this subject, and discusses the behaviour of cement and vitrified pipe and sewer construction. 3500 w. Munic Engng—April, 1906. No. 75936 C.

Cost of Cleaning a Large Brick Sewer. Frederick L. Ford. Read before the Conn. Soc. of Engrs. Reports the cost of cleaning the Franklin avenue sewer, of Hartford, Conn. 1000 w. Munic Engng—April, 1906. No. 75935 C.

New Collector for the Sewage Purification Plant at Hamburg (Le Nouveau Collecteur et la Station d'Epuration des Eaux d'Egouts de Hambourg). Describing especially the sinking of the inverted siphon across the inner harbor. 2000 w. 1 plate. Génie Civil—March 24, 1906. No. 76214 D.

WATER SUPPLY.

Filtration.

Reinforced Concrete Filter Bed Walls and Roofs, Indianapolis, Ind. William Curtis Mabee. An illustrated article describing the general design and methods of construction, and reporting cost. 3500 w. Eng News—April 26, 1906. No. 76336.

The Official Prussian Tests of the Jewell Water Filter. An account of the tests conducted by the Royal Prussian Institution and the results. 6000 w. Eng Rec—April 21, 1906. No. 76324.

The Washington Water Filtration Plant. E. D. Hardy. Gives illustrations and particulars of this plant for treating the water of the Potomac River by slow sand filtration. 1200 w. Eng Rec—April 7, 1906. No. 75982.

Fire Protection.

Underwriters' Committee of Twenty on Fire Protection in New York, Chicago and Detroit. Information from recent reports, relating to the water supplies, based on thorough investigations made by experts. Also editorial. 6000 w. Eng News—April 26, 1906. No. 76337.

Water Supply, Fire Protection and Conflagration Hazard at San Francisco, Cal. Outlines some of the conditions prevailing in the city at the time of the disaster, and gives an abstract of the report of the Committee of Twenty of the National Board of Fire Underwriters.

3300 w. Eng News—April 26, 1906. No. 76341.

Subterranean Water Supply. John Richards. Read before the Engng Cong., Lewis & Clark Ex. Refers to conditions on the Pacific Coast, discussing the development of high-pressure centrifugal pumps. Ills. 2500 w. Jour Assn of Engng Socs—Feb., 1906. No. 76113 C.

Ground Water.

Preliminary Investigations of Water Supply (Ueber Voruntersuchungen für Wasserversorgungen). Dr. Philipp Forchheimer. Describing methods of making borings, determination of quality and quantity of flow of ground water, temperature measurements, and similar preliminary work for water-supply from wells and springs. Discussion. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 30, 1906. No. 76225 D.

Irrigation.

A New Irrigation System. M. Alger, in *Am. Home & Garden.* Illustrated description of a system invented by Dr. August Koren, Jr., a Norwegian physician, especially adapted for gardens and small farms. 1000 w. Sci Am Sup—April 7, 1906. No. 75930.

The Inundation of the Salton Basin by the Colorado River and How It Was Caused. Allen Day. Describes and illustrates an inundation of great magnitude caused by work in connection with irrigation of a portion of the Colorado desert. 1700 w. Sci Am—April 14, 1906. No. 76037.

Ozone.

Apparatus for the Sterilization of Water by Means of Ozone. Dr. Gg. Erlwein. Translated from *Gesundheit.* Illustrates and describes various outfits for ozone sterilization, adapted to different requirements. 1800 w. Sci Am Sup—April 14, 1906. No. 76038.

Pumping Station.

The Pumping Station at Messein for the Supply of the City of Nancy (Usine Elévatoire de Messein pour l'Alimentation de la Ville de Nancy). A. M. J. Mauduit. An illustrated description of the station on the Moselle, using centrifugal pumps driven by electric motors. The motive power is derived from the river. 3000 w. Génie Civil—March 31, 1906. No. 76217 D.

Rates.

The Principles Governing the Valuation for Rate-Fixing Purposes of Water Works Under Private Ownership. Arthur L. Adams. Read before the Engng. Cong., Lewis & Clark Ex. Considers in detail the fundamental factors influencing value. 7500 w. Jour Assn of Engng Socs—Feb., 1906. No. 76114 C.

Reconstruction.

The Reconstruction of the Ottumwa, Ia., Water Works. A new pumping station and other improvements are illustrated and described, and the general plan of the system outlined. 2000 w. Eng Rec—March 31, 1906. No. 75885.

Reservoirs.

Reservoir at Ft. Meade, S. D. S. H. Rea. Illustrated description of a recently completed reservoir constructed of reinforced-concrete. 2800 w. Munic Engng April, 1906. No. 75934 C.

Waste.

The Business View of Water Waste. Editorial showing that frequently the prevention would cost more than the waste, and that each problem must be studied separately. 1200 w. Eng Rec—March 31, 1906. No. 75880.

Water Softening.

Practical Water Softening for Municipalities. C. Herschel Koyl. Considers methods of improving the supply for drinking and industrial uses. 2500 w. Munic Jour & Engr—April 4, 1906. No. 75942 C.

Water Works.

The New Water-Works and Reinforced Concrete Conduits of the City of Mexico. James D. Schuyler. Illustrations and brief description of a system for supplying pure spring water under ample pressure. 1200 w. Eng News—April 19, 1906. No. 76129.

Well Drilling.

The Work of Well-Drilling Machines on the Pennsylvania R.R. Low Grade Freight Line. W. R. Hulbert. An illustrated article describing the work done by these machines and the results attained. 1500 w. Eng News—April 12, 1906. No. 76051.

WATERWAYS AND HARBORS.

Antwerp.

Extension of the Port of Antwerp. An account of the proposed enlargement of the port, showing plan that will make it one of the most commodious ports in the world. 2000 w. Engr, Lond—April 13, 1906. No. 76307 A.

The Improvements at the Port of Antwerp (Les Nouveaux Agrandissements du Port d'Anvers). A description, with map of the plans for the enlargement of the port of Antwerp, including the straightening of the channel of the Scheldt, and the extensive new docks. 1800 w. Génie Civil—March 17, 1906. No. 76213 D.

Bohemia.

The Construction of the Lateral Canal from Wranan to Horin (Der Bau des Lateralkanales von Wranan nach Horin). W. Rubin. With illustrations of the construction work on a waterway 10 kilometres long by the Moldau in Bohemia, with details of the locks for a fall of 9 metres. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 30, 1906. No. 76224 D.

Canals.

See Industrial Economy.

Channels.

The Buoying and Lighting of Navigable Channels. Brysson Cunningham. An illustrated article discussing the essential features of any satisfactory system with especial reference to English practice, but giving also the regulations of other countries. 4000 w. Engng—April 6, 1906. Serial. 1st part. No. 76078 A.

Drainage.

The Drainage of the Florida Everglades. S. L. Lupfer. An interesting account of the difficulties met in surveying the Everglades, discussing the question of canal routes, and describing the dredges to be used. 4000 w. Eng News—April 5, 1906. No. 75947.

Dredge.

The Sea Going Bucket Dredge, Fedor Solodoff (Der Seetuchtige Eimerbagger Fedor Solodoff). A. v. Overbeeke. Illustrated description of a ladder bucket dredge, with suction and discharge pipes for use in the sea of Azov, at the mouths of the Danube and the Don. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76204 D.

Excavation.

Cost of Canal Excavation Through Peat and Soft Material. Information concerning the work accomplished by a Lidgerwood duplex traveling cableway of special design, in construction at the Hennepin Canal, near Wyanet, Ill. 900 w. Eng Rec—April 7, 1906. No. 75984.

Excavator.

A German Excavator on the New York Barge Canal. Emile Low. Brief account of the work near Oneida Lake, and an illustrated description of the type of excavator with transporter used. 700 w. Eng Rec—April 21, 1906. No. 76325.

Levees.

Levee and Drainage Works at Memphis. Describes the area requiring protection along the banks of the Mississippi, the levees, and a pumping plant having several unusual features. 4500 w. Eng Rec—April 21, 1906. No. 76323.

Obstructions.

Submarine Sweeps for Locating Obstructions in Navigable Waters. Francis C. Shenehon. Illustrates and describes the Lake Survey Pontoon Speed Sweeps, and describes other forms tried. 3300 w. Eng News—April 26, 1906. No. 76338.

Ostend.

The Ostend Harbor Extensions. Gives briefly the history of this port of Belgium, and describes the harbor improvements in progress. 2500 w. Engng—April 13, 1906. 76199 A.

Panama.

Concerning the Gatun Dam. Substance of the testimony of Prof Wm. H. Burr, before the Senate Committee, favoring the sea-level canal; and of Frederic P. Stearns in answer to the criticisms of the design of this dam. Also editorial. 10500 w. Eng News—March 29, 1906. No. 75865.

Recent Controversy and Conditions at Panama. Fullerton L. Waldo. A letter discussing the sea-level plan and the work thus far accomplished on the isthmus. 1800 w. R R Gaz—April 20, 1906. No. 76150.

The Probable Tonnage of the Panama Canal. Editorial discussing the views of John F. Wallace, Prof. Emory R. Johnson, and the estimates published, and the bearing on the type of canal to build. 3500 w. Eng News—April 19, 1906. No. 76132.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Cable Gear for a new Japanese Cable Ship. Gives plan and elevation of the ship, and illustrated description of the machinery, especially the combined picking-up and playing-out machine. 1500 w. Elect'n, Lond—March 23, 1906. No. 75901 A.

Maintenance.

Care and Maintenance of Equipment. R. A. Walker. Read before the Iowa Telephone Assn. Considers the care of office equipment, cables and aerial lines, and instruments. 2000 w., Elec Rev, N Y—April 14, 1906. No. 76054.

Pupin System.

Observations on the Pupin Telephone System (Beobachtungen an Telephonleitungen Pupinschen Systems). Robert Nowotny. An account of experience with the long-distance line between Vienna and Innsbruck showing the improvement due to the Pupin loading coils. 3000 w. Elektrotechnik u Maschinenbau—April 1, 1906. No. 76255 D.

Space Telegraphy.

The Bell Tetrahedral Kite in Wireless Telegraphy. An illustrated account of the recent successful transmission of messages between Long Island and Ireland, by means of kite-supported aerials. 800 w. Sci Am—April 21, 1906. No. 76134.

Wireless Telegraphy by Means of Kites. Waldon Fawcett. An illustrated article describing the experiments being carried out by Dr. A. Graham Bell, in the utilization of tetrahedral kites as an aid in wireless telegraphy. 500 w. Elec Rev N Y—April 7, 1906. No. 75993.

Telephony.

Telephone Engineering as a Profession. C. E. Scribner. Discusses phases of telephone engineering and the problems, and the opportunity for young engineers in this field. 4500 w. Sib Jour of Engng—March, 1906. No. 76095 C.

Telephone Engineering. J. J. Carty. Discusses the true scope of telephone engineering, presenting a typical problem in telephone management, illustrating the points made. 10200 w. Am Inst of Elec Engrs—March, 1906. No. 76116 D.

The Application of Self-Induction to Long-Distance Telephony. Aims to give some account of the theory now generally admitted to be correct, and to show its application to the problem of long-distance telephony. 4000 w. Elec Engr, Lond—April 6, 1906. No. 76071 A.

The Telephone Cable. G. S. Macomber. Illustrates and describes the manufacture of the standard telephone cable, with information relating to their use. 2200 w. Sib Jour of Engng—March, 1906. No. 76096 C.

DISTRIBUTION.

Cables.

Comments on Underground Cable Practice. Wallace S. Clark. Discusses the advisability of omitting metallic sheaths, and mentions other features of cable materials, and construction, and of tests. Gives specifications adopted by the Rubber-Covered Wire Engineers' Association. 2500 w. Am Inst of Elec Engrs—April 27, 1906. No. 76369 D.

Conduits.

Conduit Wiring for Electric Installations. L. M. Waterhouse. Abstract of a paper read before the Nat. Elec. Contractors' Assn., Lond. Discusses methods of conduit wiring, the materials, etc. 2000 w. Elec Engr, Lond—March 23, 1906. No. 75898 A.

The Long-Distance Underground Conduit System of the American Telephone and Telegraph Company between New York, N. Y., and New Haven, Ct. Illustrates and describes the recently completed conduit system from Stamford to New Haven, which connects with the previously built line to New York. The construction work is described. 1900 w. Elec Rev, N Y—April 14, 1906. No. 76053.

Insulation.

Standardizing Rubber-Covered Wires and Cables. John Langan. Emphasizes the importance of using the best Para rubber, and gives tensile and other tests for determining it; and proposes a set of specifications for cables. 5000 w. Am Inst of Elec Engrs—April 27, 1906. No. 76368 D.

Rotary Converters.

Some Notes on the Regulation of Rotary Converters. Alfred Still. Explains how compound winding of rotary converters enables the pressure across brushes to be maintained constant at all loads. 1400 w. Elec Rev, Lond—April 13, 1906. No. 76142 A.

Sub-Station.

Transformer Sub-Station at the St. Lazare Railway Station, Paris (Sous-Station de Transformation d'Energie Electrique de la Gare Saint-Lazare, Paris). J. Vinson. The primary current is supplied at 5000 volts and 25 cycles from the Molineaux generating station, and transformed to a continuous current at 125 volts for use in the railway terminal. 2000 w. 1 plate. Génie Civil—March 17, 1906. No. 76211 D.

Wires.

Some Notes on Wires. Thomas Carter. Notes compiled for the purpose of comparing different wires available for electrical resistance of various types. 1000 w. Elec Rev, Lond—March 30, 1906. No. 76004 A.

ELECTRO-CHEMISTRY.

Electric Furnaces.

Potential Regulation for Large Electric Furnaces. H. R. Stuart. Considers methods for regulating the current supplied to electric furnaces, and the devices used. Ills. 1500 w. Elec Jour—April, 1906. No. 76354.

Electric Smelting.

Electric Smelting of Magnetite Ores: Successful Experiments at Sault Ste Marie. An address delivered by Dr. Eugene Haavel before the Canadian Club, Toronto, on March 12, 1906. An account of the experimentation on Canadian ores at the Soo, giving illustrated description of the electric furnace. The results are pronounced successful. 3800 w. Can Engr—April, 1906. No. 75923.

Electrolytes.

Factory Scale Experiments with Fused Electrolytes. Edgar A Ashcroft. Deals with special lines of practical electrolytic work with which experimental trials have been conducted on a scale comparable to factory conditions. Ills. 3000 w. Elec Chem & Met Ind—April, 1906. Serial. 1st part. No. 76028 C.

Electrothermics.

Electrothermics of Iron and Steel. Ch. A Keller. Abstract of a paper read before the Faraday Soc. Gives results obtained in 1905 in the production of iron and steel by the electric furnace at the Livet Works, France. 1500 w. Ir & Coal Trade Rev—April 13, 1906. No. 76311 A.

Hypochlorite.

The use of Electrolytic Hypochlorite as a Sewage Sterilizing Agent in the United Kingdom. John B. C. Kershaw. Gives details of the hypochlorite cells which have been patented and worked in the United Kingdom. Ills. 2700 w. Elec Chem & Met Ind—April, 1906. No. 76025 C.

Nitrogen.

Fixation of Atmospheric Nitrogen. Prof. Philippe A. Guye. Slightly abridged paper read before the Swiss Soc. of Nat. Science. A summary of the application of modern principles of physical chemistry to the combustion of nitrogen. Also editorial. 5000 w. Elec Chem & Met Ind—April, 1906. No. 76026 C.

Southern Water-Powers and Fertilizer. C. H. Z. Caracristi. Deals with the process of obtaining nitrogen from the atmosphere, reviewing the papers by Sir William Crookes and Professor Sylvanus P. Thompson, and the work at the factory in Norway. 5500 w. Mfrs Rec—April 12, 1906. No. 76043.

ELECTRO-PHYSICS.

Flux-Distribution.

Flux-Distribution in Machines with Commutating Poles. Thomas F. Wall and Stanley P. Smith. Experimental investigations are described and discussed. 1500 w. Elect'n, Lond—April 6, 1906. No. 76074 A.

Harmonics.

The Utility of Methods of Avoiding Harmonics in Alternating-Current Machinery (Sur l'Utilité et les Moyens d'Eviter les Harmoniques dans les Appareils à Courants Alternatifs). F. C. Guéry An exhaustive study of harmonic action in high-tension alternating-current circuits, showing how such action may be checked at its inception. 9000 w. Bull Soc Ind des Electriciens—March, 1906. No. 76267 G.

Magnetic Field.

An Investigation into the Periodic Variations in the Magnetic Field of a Three-Phase Generator by Means of the Oscillograph. G. W. Worrall and T. F. Wall. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. A report of investigations made to obtain experimental records of the variations referred to under various conditions of load. 1100 w. Elect'n, Lond—April 13, 1906. No. 76194 A.

Magnets.

Method of Design for Magnet Windings. F. Albert Willard. Outlines methods which may be used in the design of any winding, and if followed closely will give accurate results. 800 w. Elec Wld—April 21, 1906. No. 76184.

GENERATING STATIONS.

Accumulators

Economic Considerations in the Employment of Storage Batteries. J. R. Salter. Abstract of paper and discussion before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses the advantages claimed, and concludes that they are not justified by the cost at which they are obtained. Also editorial 5500 w. Elect'n, Lond—April 6, 1906. No. 76075 A.

Maximum efficiency of a Storage Battery. Benjamin F. Bailey. Describes a test made to get the highest possible efficiency from a storage battery. The experiments showed a quantity efficiency of almost 100 per cent, and a watt-hour efficiency of 91.8 per cent. 700 w. Elec Wld—April 21, 1906. No. 76186.

Bohemia.

Hohenfurth Plant in Bohemia. C. L. Durand. Illustrated description of the hydraulic station recently erected on the Moldau river. The current is distributed by a high-tension line operated on the three-phase system, and is used mainly in paper-making establishments. 2500 w. Elec Rev, N Y—March 31, 1906. No. 75846.

Boosters.

The Application of Automatic Boosters in Electric Stations (Anwendung von Selbsttätigen Zusatzmaschinen für Elektrizitätswerke). L. Schröder. Discussing especially the use of auxiliary dynamos in connection with the operation of street railway power stations. 3000 w. Elektrotechnik u Maschinenbau—April 8, 1906. No. 76256 D.

Commutators.

Computations for the Number of Elementary Groups and the Pressure between two Adjoining Commutator Segments (Berechnung der Zahl der Elementengruppen und der Spannung Zwischen Zwei Benachbarten Kollektorlamellen). N. Gennimatas. A mathematical discussion of the distribution of voltage between commutator segments. 2500 w. Elektrotechnik u Maschinenbau—March 25, 1906. No. 76254 D.

New Methods in the Care of Brush Arc Generator Commutators. C. M. Green. Directions with illustrations.

1000 w. Elec Wld—April 7, 1906. No. 76090.

Costs.

Rates for Electric Current in Chicago. A report to the Gas, Oil and Electric Light Committee of the Chicago City Council by B. J. Arnold and William Carroll. 3800 w. Eng Rec—April 14, 1906. No. 76315.

The Cost of Electricity Per Unit from Private Electrical Plants. Review of a paper by Wilson Hartnell, before the Leeds Loc. Sec of the Inst. of Elec. Engrs., criticizing the accuracy of some statements made. 1200 w. Elec Engr, Lond—March 23, 1906. No. 75899 A.

Extensions.

Recent Extensions at the Manchester Electricity Works. An illustrated account of some of the more important extensions recently made. The present article describes the 500 k.w. La Cour motor-converters, the principle and design. 2700 w. Elect'n, Lond—March 30, 1906. Serial. 1st part. No. 76007 A.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hydro-Electric.

Hydro-Electrical Installations of Upper Italy. From a paper read by G. Semenza, before the Society of Civil Engrs. of France. Explains why the installation of hydro-electrical machinery is of immense value to Italy, and gives information of a number of important instalments. 3000 w. Elec Engr, Lond—March 30, 1906. No. 76003 A.

Hydro-electric Development in the Adirondacks. Illustrates and describes the plant at Hannawa Falls, where the water of the Raquette River drives the electric generators, and turns the wheels that operate the grinders of a pulp mill. 3000 w. Elec Wld—April 21, 1906. No. 76183.

Hydro-Electric Power Plants of California. C. W. Whitney. Reviews briefly the electrical and hydraulic developments of some of the typical power plants of the State. Ills. 7500 w. Cal Jour of Tech—Feb., 1906. No. 75957 C.

The Electric Station at Wagnen on the Aar (Das Elektrizitatswerk Wangen a. d. Aare). L. Zodel. A fully illustrated description of a plant developing 9000 h. p. from the hydraulic power of the Aar, being the largest hydro-electric station in Switzerland. Two pairs of horizontal turbines are direct-connected to each dynamo. Two articles, 3000 w. Schweiz Bauzeitung—April 7, 14, 1906. No. 76251 each B.

The Hauterive Power Station (Usine de Hauterive). A. Weber. A fully illustrated description of the hydro-electric station on the Sarine, in the Canton of Fribourg, Switzerland, for the development of 10,000 horse power. 5 articles, 8000 w. Bull Tech de la Suisse Romande. Jan. 25, Feb. 10, 25. March 10, 25, 1906. No. 76263 each D.

The Hydraulic Power Development of the Animas Power and Water Co. George M. Peek. Illustrated description of this plant in Colorado, built by a company incorporated for the purpose of building irrigation canals, reservoirs, and developing water power. 1600 w. Eng Rec—April 14, 1906. No. 76319.

The Hydro-electric Plant of the Animas Power and Water Company. Malcolm Lloyd. Illustrated description of a hydraulic power plant in the southwestern part of Colorado which promises to revolutionize the mining and commercial industries of the region. 3500 w. Elec Rev, N Y—April 21, 1906. No. 76158.

The Sill Electricity Works. Illustrated description of one of the most important hydro-electric plants recently installed in the Austrian Alps. It is designed for a capacity of 15,000 h. p. with high-pressure Pelton turbines, and will supply Innsbruck and its vicinity with electricity. 2300 w. Engr, Lond—March 23, 1906. No. 75909 A.

Isolated Plants.

Electrical Equipment of Wanamaker's New York Store. Illustrated description of this installation for lighting, motors, heating, ventilating and mechanical service. 2700 w. Elec Wld—March 31, 1906. No. 75887.

Installation and Maintenance of a Small Electric Light Plant. An illustrated description of the plant at Jordan, Minn., a town of 1200 inhabitants. 2500 w. Power—May, 1906. No. 76362 C.

The Central Station for the Armour Plants. Illustrated description of a plant for supplying power to a collection of factory buildings. 3500 w. Engr, U S A—April 2, 1906. No. 75889 C.

Municipal Plant.

A Municipal Steam Turbine Station at Columbus, Ohio. Illustrates and describes interesting details of the plant for street arc lighting. 2800 w. Eng Rec—March 31, 1906. No. 75882.

Parallel Operating.

Regulating Compound-wound Dynamos Operating in Parallel. Directions with diagrams. 1200 w. Power—April, 1906. No. 75856 C.

Power Houses

The Long Island City Power Station of the Pennsylvania Railroad Company's Extensions to New York and Long Island. Illustrated detailed description of the plant and its equipment. 9200 w. St. Ry Rev—April 15, 1906. No. 76061 C.

The Pennsylvania Railroad's Extension to New York and Long Island. An illustrated article dealing principally with details of the Long Island City power station. 10000 w. Eng Rec—April 7, 1906. No. 75985.

The Pennsylvania Railroad's Extension to New York and Long Island—The Long Island City Power Station. Illustrated detailed description, dealing principally with the station and its equipment. 1200 w. St Ry Jour—April 7, 1906. No. 75990 C.

The Long Island City Power Station. Illustrated detailed description of the design and equipment. 4200 w. Ir Age—April 5, 1906. Serial. 1st part. No. 75920.

The Long Island Power Station of the Pennsylvania, New York and Long Island Railroad. Illustrated, detailed description of the station which is to furnish the very large amount of power needed by the Long Island Railroad, the new lines which are to tunnel under the East River, and the Atlantic Ave. improvement. 3000 w. Power—April, 1906. No. 75855 C.

The Nassau (L. I.) Light and Power Company. An illustrated account of the development of a company covering the territory of a large portion of the central part of Long Island, involving distribution to a large number of small villages. 3800 w. Elec Wld—April 7, 1906. No. 76087.

The New Lighting and Power Station at Glenwood. Illustrated description of this new station of the Nassau Light & Power Co., which will supply electricity to the central part of Long Island. 6500 w. Eng Rec—April 14, 1906. No. 76314.

Records.

The Keeping of Consumers' Records in Electric Supply Undertakings. Describes a system found very successful. 1000 w. Elec Rev, Lond—March 23. 1906. No. 75900 A.

Re-Winding.

Rewinding Dynamo Electrical Machinery. Norman G. Meade. Explains, with the aid of diagrams, a method of repairing electrical machinery that can be adopted by manufacturing concerns having their own electric plants. Confined to direct-current machinery. 1600 w. Power—May, 1906. No. 76365 C.

Switchboards.

Switchboard Arrangement for Central Power Plants (Vereinigte Schaltung und Bedienung von Betriebsmaschinen in Elektrischen Zentralen). Karl Wertenson. Describing the arrangement at the municipal plant at Riga, in which the control of all the machinery is centralized at one switchboard. 2000 w. Zeitschr d Ver Deutscher Ing—April 14, 1906. No. 76209 D.

LIGHTING.

Frequency.

Lighting on 25 Cycles in Buffalo. H. B. Alverson. On the success with 25-cycle lighting with incandescent lamps, and some causes that affect the illumination. 1500 w. Elec Jour—April, 1906. No. 76356.

The Variation of Candle-power Due to Frequency. P. O. Keilholtz and B. Harrison Branch. Reports experiments performed to determine the variation in the intensity of illumination of any incandescent lamp on a 25-cycle alternating-current circuit. Also editorial. 3000 w. Elec Jour—April, 1906. No. 76355.

Lamps.

The Economical Life of Incandescent Lamps. Lancelot W. Wild. Aims to show the relation existing between the economical life of ordinary commercial carbon filament incandescent lamps and the price per unit for electrical energy. 600 w. Elec Rev, Lond—April 6, 1906. No. 76072 A.

Photometry.

See Electrical Engineering, Measurement.

Residence Lighting.

An Example of House Lighting Design. J. R. Cravath and V. R. Lansingh. Gives plan and designs for a house recently built in Pasadena, Cal., where excellent illumination with a minimum operating cost was desired. 1800 w. Elec Wld—April 7, 1906. No. 76089.

Waste.

Waste in Incandescent Electric Lighting. Refers to methods described in paper by George Wilkinson, and offers suggestions for lessening the waste. 2200 w. Elec Rev, Lond—April 13, 1906. No. 76144 A.

MEASUREMENT.

Meters.

Defective Connections for Three-Phase Meters (Falsche Drehstromzähler Schaltungen). F. Niethammer. A discussion of the importance of using correct connections of the voltage coils of double meters for three-phase currents in order to insure correct measurements. 1200 w. Elektrotech u Maschinenbau—March 18, 1906. No. 76252 D.

Photometry.

A Portable Selenium Photometer for Incandescent Lamps. Dr. Theo. Torda. Describes an apparatus based upon the action of the light on selenium, which alters its electric resistance with variations, of the intensity of light. 2800 w. Elect'n, Lond—April 13, 1906. No. 76193 A.

Experimental Researches in Photometry.

(Untersuchungen auf dem Gebiete der Photometrie). Karl Satori. A study of the relation of spectroscopy to photometry, showing the importance of comparing lights of corresponding wave lengths. Discussion. 5000 w. Elektrotech u Maschinenbau—March 18, 1906. No. 76253 D.

The Measurement of Illumination (Beleuchtungsmessungen). F. Uppenborn. Discussing especially the methods used in the laboratory of the municipal electric station in Munich and the use of the Martens photometer. 1500 w. Elektrotech Zeitschr—April 12, 1906. No. 76258 B.

MOTORS.

Induction Motors.

Graphic Representation of Induction Motor Phenomena. A. S. M'Allister. Aims to show that the primary current cannot be accurately represented by any circle, but that the secondary current locus is a true circle. Also editorial. 3000 w. Elec Wld—April 21, 1906. No. 76185.

Starting Torque of Induction Motors. R. E. Hellmund. Deals with the predetermination of the commercial starting torque. Also editorial. 1800 w. Elec Wld—March 31, 1906. No. 75888.

The Separation of the Losses in Induction Motors. G. W. O. Howe. Reviews methods suggested by Benischke, and by Messrs. Bragstad and La Cour and the experiments of Herr Bache-Wüg. 1400 w. Elect'n, Lond—March 30, 1906. No. 76008 A.

Inter-Pole.

The Advantages of the Inter-Pole Design in Railway Motors. G. Herbert Condict. A statement of the advantages of this type of motor in direct-current-practice, illustrating graphically some features. 900 w. St Ry Jour—April 21, 1906. No. 76174 C.

Motor Standards.

Standard Conditions for the Use of Motors in Connection with Public Electric Stations (Normale Bedingungen für den Auschluss von Motoren au Oeffentliche Elektrizitätswerke). L. Schuler. A review of the proposed regulations of the German Electotechnical Association relating to the conditions under which electric motors may receive current from municipal lighting stations. 2500 w. Elektrotech Zeitschr—April 12, 1906. No. 76257 B.

Speed Control.

Speed Characteristics and the Control of Electric Motors. C. F. Scott. Mr. Scott's second paper treats of practical applications of alternating-current motors to the driving of machine tools; with numerous illustrations of working installations. 3000 w. Engineering Magazine—May, 1906. No. 76274 B.

The Adaptability of Variable Speed Motors. Explains the advantages of the plain variable speed motor. 1000 w. Elec Rev, Lond—March 30, 1906. No. 76005 A.

Wiring.

The Wiring and Maintenance of Shunt and Compound-Wound Motors. William Kavanagh. Considers the wiring and care of both types. Ill. 1000 w. Elec Wld—April 7, 1906. No. 76088.

TRANSMISSION.

Niagara.

The Niagara-Syracuse Transmission Line. Orrin E. Dunlap. An illustrated description of this long transmission line. 2500 w. Elec Wld—April 14, 1906. No. 76157.

Protective Devices.

Lightning Protection. Newton Harrison Explains the conditions that cause lightning, and discusses the means adopted to secure immunity from shock or fire. 1800 w. Cent Sta—April, 1906. No. 75998.

INDUSTRIAL ECONOMY

Canals.

The Law of Canals. J. H. Cockburn. A discussion of English law in regard to questions relating to canals. 2200 w. Col Guard—April 6, 1906. Serial. 1st part. No. 76077 A.

Coal Strike.

The Meaning of the Coal Strike in the United States. F. E. Saward. A review of the present actual conditions in the anthracite and bituminous coal fields of the United States and a discussion of the points at issue between the miners and operators in the spring of 1906. 3500 w. Engineering Magazine—May, 1906. No. 76278 B.

Commerce.

American Commercial Relations: A Coming International Problem. M. A. Oudin. A discussion of the rapidly rising importance of the American export trade and the necessity of adopting improved methods for its development. 4000 w. Engineering Magazine—May, 1906. No. 76271 B.

Commercial Engineering.

Problems That Confront Engineering and Kindred Industries on the Pacific Coast. George W. Dickie. Read before the Engng Cong., Lewis & Clark Ex. Deals mostly with the commercial problems, stating the conditions to be met. 5000 w. Jour Assn of Engng Socs—Feb. 1906. No. 76115 C.

Education.

The College Shop. Dexter S. Kimball. Briefly explains the aim in manual training schools, trade schools, and engineering colleges, discussing the college shop in detail. Ills. 3800 w. Am Mach —Vol. 29, No. 16. No. 76125.

The Education of Mining and Metallurgical Engineers. Prof. John Bonsall Porter. Read before the Can. Min. Inst. Outlines the course of study which will give the best preparation possible. Many illustrations accompany this article. 3800 w. Can Min Rev—April, 1906. No. 76181 B.

The Successful Apprenticeship and Educational System of the General Electric Co., West Lynn, Mass. An address by M. W. Alexander, who developed the system, describing its features. 4200 w. Mach, N Y—April, 1906. No. 75879 C.

The Teaching of Metallurgy in College Laboratories, and a Description of the Equipment and Uses of the Metallurgical Laboratories at McGill. Dr. A. Stansfield. Considers the use and limitations of such teaching, and describes the equipment at McGill University. Ills. 4000 w. Can Min Rev—April, 1906. No. 76182 B.

Iron Industry.

The Iron and Steel Industries of the United States (L'Industrie Sidérurgique aux Etats Unis). G. Rivière. A statistical and descriptive review of the industry in America, with illustrations and plans of the principal plants. 18000 w. 3 plates. Mem Soc Ing Civ de France—Feb., 1906. No. 76237 G.

Labor.

The Condition of the German Working-man. Earl Dean Howard. Abstract of a chapter of the author's essay upon "The Cause and Extent of the Recent Industrial Progress of Germany." An interesting discussion of the factors other than wages which affect the condition. 6500 w. Ir & Coal Trds Rev—April 6, 1906. No. 76085 A.

Philippines.

Transportation Systems and Projects in the Philippines. L. W. Bennett. A handsomely illustrated account of the resources, needs, and special industrial, agricultural and commercial features of the islands. 3500 w. Engineering Magazine—May, 1906. No. 76273 B.

Piece-Work.

A Rational Method for the Introduction and Management of Piece-Work in Railroad Shops. William S. Cozad. Read before the New England R. R. Club. Describes the organization worked out for the Erie R. R. on the piece-work system. 2400 w. R R Gaz—April 13, 1906. No. 76048.

Rate Regulation.

President Stickney on Rate Regulation. Extract from a paper in the *Political Science Quarterly,* for March, 1906. Advises an interstate commerce investigation committee outlining the work it should undertake, before legislation is framed. 2500 w. R R Gaz—April 6, 1906. No. 75955.

The Hepburn Bill. Editorial discussion of this bill for rate regulation, pointing out the good and bad features. 2000 w. R R Gaz—April 27, 1906. No. 76377.

Works Management.

A History of the Introduction of a System of Shop Management. James M. Dodge. An account of the introduction of the Taylor system, and the results. Discussion. 3500 w. Am Soc of Mech Engrs, No. 094—May, 1906. No. 76111.

The Commercial Organization of Engineering Factories. Henry Spencer. The first of a series of articles describing the whole commercial routine of an engineering factory, especially the principles of organization. 3000 w. Engr, Lond—March 30, 1906. Serial. 1st part. No. 76015 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trials of the U. S. Battleship Virginia. Gives the dimensions, armament, and report of trials. 1500 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76349 H.

The Japanese Battleship Kashima. Illustration, with description of the vessel and its armament, and report of trials. Built in England. 2300 w. Engng —April 13, 1906. No. 76303 A.

The U. S. Battleship Louisiana. Illustration, with description and report of trials. 16000 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76350 H.

U. S. Battleship Rhode Island. Charles B. Edwards and Ralph L. Lovell. Illustration, with description and report of official trial. 4000 w. Jour Am Soc of Nav Engrs—Feb., 1906. 76344 H.

Bearings.

An Investigation of the Pressures upon the Main Bearings and Crank Pins of Marine Engines. Edward M. Bragg. Reports an investigation undertaken with the object of finding an approximate method for the determination of the loads to which the crank-shaft bearings of a proposed engine would be subjected. Diagrams. 6500 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76345 H.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Doors.

Official Tests of Electrically Operated Bulkhead Doors. A report of the official trials made by the United States Navy Department. Ills. 1800 w. Marine Engng—April, 1906. No. 75859 C.

Cable Steamer.

See Electrical Engineering, Communication.

Colonial Service.

Vessels for Colonial Service. Sir Edward J. Reed. Read before the Inst. of Naval Archts. On the construction of new vessels, and the renewal of details. Deals with a variety of types. Ills. 14000 w. Engng—April 6, 1906. No. 76082 A.

Cruisers.

French Armored Cruisers. J. Peltier. Gives particulars of the types built since 1898, with illustrations. 1500 w. Marine Engng—April, 1906. No. 75857 C.

Peruvian Cruiser, Almirante Grau. Brief description of this twin-screw protected cruiser for the Peruvian Navy. 1000 w. Engng—March 23, 1906. No. 75912 A.

Docks.

Large Floating Docks (Les Grands Docks Flottants). L. Piaud. A general description of the modern self-docking sectional floating dock with illustrations of recent examples, including the docks at Hamburg, Cavite, and Tsing-Tao. Two articles. 5000 w. Génie Civil—March 17, 24, 1906. No. 76212, each D.

Electric Installations.

Electricity on Atlantic Liners. Illustrated description of the installation on the twin-screw steamship Amerika, showing the many applications made of electricity. 2300 w. Engr, Lond—March 23, 1906. No. 75908 A.

Ferry Steamers.

American Train Ferry Steamers. Illustrates and describes types in service at San Francisco, New York, on the Great Lakes, and at other points. 1400 w. Engr, Lond—March 23, 1906. Serial. 1st part. No. 75907 A.

Gas Propulsion.

See Mechanical Engineering, Combustion Motors.

Liners.

The New Amsterdam, Latest Trans-Atlantic Liner, Reaches New York on Her Maiden Trip. Illustrated description of the new twin-screw steamship "New Amsterdam," of the Holland-America Line. 1800 w. Naut Gaz—April 19, 1906. No. 76160.

The Steamship Provence of the French Transatlantic Line (Le Paquebot "La Provence" de la Compagnie Générale Transatlantique). A. Dumas. With numerous illustrations of the latest addition to the French line. The displacement is 19,160 tons, and speed 21 knots. Serial. Part I. 1 plate. 2000 w. Génie Civil—April 7, 1906. No. 76219 D.

Motor Boats.

Motor Boats. Bernard B. Redwood. Discusses the possibilities of the internal combustion engine for marine propulsion. Discussion. Ills. 7800 w. Jour Soc of Arts—March 23, 1906. No. 75891 A.

100-Horse-Power Suction-Gas - Propelled Boat on the River Rhine. Illustrated description of the boat "Lotte," a flat-bottomed barge measuring 139 feet 6 inches in length. It has proved highly economical in operation. 1000 w. Sci Am—April 14, 1906. No. 76036.

The Design and Construction of High Speed Motor Boats. James A. Smith. Excerpts from a paper read before the Inst. of Nav. Archts. Considers model types of high-speed launches, rendered possible by the development in internal combustion motors. 2200 w. Auto Jour—April 14, 1906. No. 76190 A.

The Speed of Motor Boats and Their Rating for Racing Purposes. Linton Hope. Excerpts from a paper before the Inst. of Naval Archts. Shows the great increase of speed since the internal combustion engine has been used, shows the use of motor boat racing in giving data applicable to the design and construction of hulls, and discusses racing rules. 2200 w. Auto Jour—April 14, 1906. Serial. 1st part. No. 76191 A.

Naval Machinery.

Suggestions for the Care and Operation of Naval Machinery in the Engineer Department U. S. Navy. H. C. Dinger. The first of a series of articles describing the main features in connection with the care and operation of naval machinery. 13500 w. Jour Am Soc of Nav Engrs—Feb. 1906. Serial. 1st part. No. 76348 H.

Propulsion.

Remarks on Screw Propulsion. R. D. Gatewood. A brief summary and discussion of the results of the theories and experiments of Rankine, the Froudes (father and son), Taylor, Greenhill, and others. 2000 w. Pro U S Nav Inst—March, 1906. No. 76100 G.

Revenue Cutter.

A New Shallow Draft Revenue Cutter. Illustrates and describes a revenue cutter designed for use on Albemarle and Pamlico Sounds in North Carolina. 3500 w. Marine Engng—April, 1906. No. 75858 C.

Scouts.

The New Scouts. C. C. P. Fitz-Gerald. Read at the Inst. of Naval Archts. Illustrations and information concerning these vessels, with general opinions on scouting and a comparison with 1901 design. 2200 w. Engng—April 6, 1906. No. 76080 A.

Shipyards.

The Introduction of Cranes in Shipyards. Alexander Murray. Read before the Inst. of Naval Archts. Discusses improvements in shipyards and the results of efficient crane service, illustrating types introduced. 3200 w. Engng—April 13, 1906. No. 76302 A.

The Overhead Wire Cableway Applied to Shipbuilding. J. L. Twaddell. Read before the Inst. of Naval Archts. Principally an illustrated description of the system at the Jarrow Yard of Palmer's Shipbuilding and Iron Co., Ltd. 4000 w. Engng—April 13, 1906. No. 76306 A.

Steamboat.

Launch of New Steamboat Hendrick Hudson. An illustrated article giving an account of the launch and describing features of this vessel which will cost nearly a million of dollars. 3000 w. Naut Gaz—April 5, 1906. No. 75988.

Steamships.

New Twin-Screw Steamship Mooltan. Illustrated description of this mail steamer built for service between the East Indies and England. 1300 w. Naut Gaz—March 29, 1906. No. 75867.

Steam Turbines.

See Mechanical Engineering, Steam Engineering.

Transatlantic.

Transatlantic Lines and Steamships. Arthur J. Maginnis. Read before the Liverpool Engng Soc. A review of the past decade, and especially the advances of the last few years. 6000 w. Marine Rev—March 29, 1906. No. 75845.

Videttes.

High-Speed Vidette Pinnaces. G. Simpson. Illustrated description of videttes built for the Imperial Japanese Navy. 2000 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76346 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Cadillac.

The Four-Cylinder Cadillac—A New Vertical Model. An illustrated article giving a summary of the features of this 1906 model. 1200 w. Auto Jour—April 14, 1906. No. 76188 A.

Chainless.

The 14-22 H. P. Germain Chainless Car. Detailed description, with illustrations. 1500 w. Autocar—April 7, 1906. No. 76069 A.

Engines.

An 18 H. P. Six-Cylinder Rotary Petrol Engine. Illustrated detailed description of an interesting engine designed by F. Lamplough, for automobiles. 1600 w. Autocar—March 24, 1906. No. 75896 A.

Rating Petrol Engines by Cylinder Dimensions. Dugald Clerk. Read before the Auto. Club, England. Gives report of tests made, discussing results. 2000 w. Auto Jour—March 31, 1906. No. 76000 A.

The Rating of Motor Car Engines. Extracts from a lecture delivered by Prof. Hopkinson, of Cambridge University, to the members of the Midland Auto Club. Discusses the origin of horse-power, the factors, the source of power, inertia forces, piston speed, etc. 2500 w. Autocar—March 24, 1906. Serial. 1st part. No. 76001 A.

Gasoline Cars.

How to Operate a Gasoline Car. Edward T. Birdsall. Points on starting, running, controlling, hill-climbing etc., are discussed. 2700 w. Automobile—April 26, 1906. No. 76370.

Humber.

The Humber Petrol Cars. Illustrated descriptions of the four and six-cylinder models. 1200 w. Auto Jour—March 24, 1906. Serial. 1st part. No. 75894 A.

Iris.

The 25-30 and 35-40 H. P. Iris Cars. Illustrates and describes the frame, engine, carburetter, throttle valve, ignition system, change-speed gear, and other features of these British built cars. 2200 w. Autocar—April 14, 1906. No. 76187 A.

Live Axle.

The Hedgeland Solid Live-Axle. An illustrated description of a device for eliminating the differential-gear in cars (chain-driven as well as live-axle), which is being officially tested, and for which non-skidding properties are claimed. 2200 w. Auto Jour—April 14, 1906. No. 76189 A.

Manufacture.

The Making of an Automobile. An illustrated article outlining the methods of an up-to-date automobile manufacturing establishment. 1600 w. Automobile —April 26, 1906. No. 76371.

Mechanical Plant.

Mechanical Plant in the Motor Mart of Boston. Howard S. Knowlton. Describes a building for the storage, repair and sale of motor vehicles, the power plant and mechanical equipment. Ills. 2500 w. Engr, U S A —April 16, 1906. No. 76127 C.

Omnibuses.

The Critchley-Norris Petrol 'Bus. Illustrates and describes the special features of this chain-driven vehicle. 1400 w. Auto Jour—March 24, 1906. Serial. 1st part. No. 75895 A.

The Field of the Electric Tramway and Motor Omnibus. E. Manville. Read before the Automobile Club. A comparison of the advantages and disadvantages of the two systems, and of the costs. 5000 w. Elec Engr, Lond—April 13, 1906. Serial. 1st part. 76192 A.

30 Horse Power Motor Omnibus. Illustrates and describes the chassis of a powerful vehicle for service in London. 1200 w. Engr, Lond—March 23, 1906. No. 75910 A.

Steam Wagon.

Motor Car Show at Islington. Illustrates and describes a five-ton steam wagon exhibited, with several features of interest. The boiler is of the top-fired locomotive pattern. Other steam vehicles are mentioned. 2500 w. Engr, Lond—March 30, 1906. No. 76018 A.

Suggestions.

Unsolved Problems in Auto Engineering. Suggestions from an address by R. E. B. Crompton in London, in regard to possible modifications in automobile construction. 4500 w. Automobile—April 12, 1906. No. 76044.

Touring Cars.

Factors Contributing to Comfort in Autos. Translated from the French of H. André in *La France Automobile.* Discusses the influence of the engine, diameter and nature of wheels and tires, and body suspension. 3500 w. Automobile—April 5, 1906. No. 75943.

COMBUSTION MOTORS.

Gas Engines.

Notes on the Design of Large Gas Engines with Special Reference to Railway Work. Arthur West. Remarks on engines suitable for important electric railway installations. Ills. 2300 w. Can Engr—April, 1906. No. 75922.

The Commercial Production of Nitric Acid in Connection with the Operation of Gas Engines. H. Diederichs. Reviews a lecture by Mr. Haeusser, before the Society of German Engineers, presenting the main points of this proposition, and discussing experimental investigations. 2000 w. Sib Jour of Engng—April, 1906. No. 76390 C.

Some Notes on Gas Engines for Electric Lighting. R. C. Dieppe. Gives some points gained from experience which may be of use in ordering gas engines for electric lighting plants. 2000 w. Elec Rev, Lond—March 30, 1906. No. 76006 A.

Gasoline Engines.

Heat Analysis of a Gasoline Engine. P. F. Walker. Describes a method worked out by the writer. 2000 w. Engr, U S A—April 2, 1906. Serial. 1st part. No. 75890 C.

Gas Power.

Gas Power Economics. F. E. Junge. Enlarged from an address delivered before the Am. Inst. of Elec. Engrs. Discusses methods and facts observed in Europe, comparing gas and steam driven Central Stations, and giving facts of interest to the iron and steel industry. 2800 w. Ir Age—April 26, 1906. Serial 1st part. No. 76312.

Gas Producer Plant for Electric Generating Stations. Wm. J. N. Sowter. Abstract of a paper and discussion before the Dublin Sec. of the Inst. of Elec. Engrs. Briefly considers bituminous producers, suction producers, gas engines, and their working, discussing their economy, etc. 4000 w. Elect'n. Lond—April 6, 1906. No. 76076 A.

Some Features of the Warren Gas Power Plant. J. R. Bibbins. Illustrated description of features in the gas engine equipment of the plant of the Warren & Jamestown Street Railway. 1800 w. Elec Jour—April, 1906. No. 76353.

"10 H. P. for an Hour for One Penny!" Abstracted from *Electrics.* Gives investigations made and a report of the trials of shops driven by suction gas plant, as compared with electricity. Considers suction gas expensive to install, of doubtful reliability, and troublesome to work. 2300 w. Elec Engr, Lond—March 23, 1906. No. 75897 A.

The Coming Power. E. R. Knowles. Presents information showing the gas engine producer system to be the cheapest in cost of any production known, and discusses its advantages. 2000 w. Elec Rev, N Y—April 21, 1906. No. 76159.

Gas Propulsion.

Gas Engines for Ship Propulsion. J. E. Thornycroft. Read before the Inst. of Naval Archts. Describes the working of a gas-engine in conjunction with a gas producer, considering the possible advantages and some of the difficulties, and gives details of a number of vessels fitted with them, which have shown satisfactory results. Ills. 4000 w. Engng—April 13, 1906. No. 76305 A.

Gas Turbines.

Notes on Prime Movers with Especial Reference to the Gas Turbine (Généralités sur les Moteurs et Spécialement les Turbines à Gaz). J. Deschamps. An examination of the application of the Carnot cycle to heat engines as in the Diesel motor, showing also the possibility of approximating this result in the gas turbine. 3000 w. Mem Soc Ing Civ de France—Feb., 1906. No. 76236 G.

The Gas Turbine (Les Turbines à Gaz). L. Sekutowicz. An exhaustive study of the theory of the gas turbine, with a discussion of the constructive features, and a review of the experimental work thus far done. 20.000 w. Mem Soc Ing Civ de France—Feb., 1906. No. 76235 G.

Ignition.

Ignition System for Gasoline Motors. Clarence B. Brokaw. From a lecture delivered before the Auto Club of America. Considers the make-and-break system, and the jump spark. 6000 w. Automobile—April 19, 1906. No. 76148.

Producer Gas.

Trials of Producer Gas Plants. R. E. Mathot. Calls attention to the manner the coal consumed in the generator should be measured, reporting tests made on producer-gas engines. 1200 w. Power—May, 1906. No. 76366 C.

Valves.

Functions of Valves in Four-Cycle Motors. Shows the arrangement and operation of the inlet and exhaust valves of a modern four-cycle gasoline motor. Ills. 2200 w. Automobile—April 19, 1906. No. 76147.

HEATING AND COOLING.

Economy.

Economy in Household Heating (Die Oekonomie der Häuslichen Heizung). Dr. E. J. Constam. Discussing especially the various stoves and heaters adapted for household use in Switzerland. 3500 w. Schweiz Bauzeitung—March 17, 1906. No. 76248 B.

Exhaust Steam.

A Distillery Power and Heating Equipment. Illustrated description of a plant in Baltimore, Md., which heats, by means of its exhaust steam, no less than 16 detached buildings. 800 w. Heat & Vent Mag—April, 1906. No. 76357.

Hot Water.

Hot Water Heating in a New York Apartment House. Illustrates and describes a gravity circulation hot-water radiation in a ten-story building. 2800 w. Met Work—April 21, 1906. No. 76141.

Refrigeration.

Mechanical Refrigeration and Its Future Development. Jos. H. Hart. A thermodynamic study of the principles of mechanical refrigeration, considering the steam engine as a reverse prototype of the compressor. 3500 w. Engineering Magazine—May, 1906. No. 76277 B.

Schoolhouse.

The Schoolhouse—Its Heating and Ventilation. Joseph A. Moore. Presents method proved by experience to give satisfactory results. Favors the downward system of ventilation. 2000 w. Heat and Vent Mag—April, 1906. Serial. 1st part. No. 76359.

Theater.

Mechanical Equipment of the New Amsterdam Theater, New York. Describes a system of upward ventilation. Ills. 1500 w. Heat & Vent Mag—April, 1906. No. 76358.

Ventilation.

Upward and Downward Ventilation. William J. Baldwin. Favors the upward system of ventilation. 2000 w. Heat & Vent Mag—April, 1906. No. 76360.

HYDRAULICS.

Governors.

Some Stepping Stones in the Development of a Modern Water-Wheel Governor. Mark A. Raplogle. Describes a mechanical governor and some of the principles that enter into its construction, showing the steps that led to the development. 5500 w. Am Soc Mech Engrs, No. 095-B—May, 1906. No. 76105.

Speed Regulation of Water-Power Plants. John Sturgess. Considers elements of design in water-wheels, and characteristics of governor action as obtained in the best practice of the present day. 3500 w. Ills. Am Soc of Mech Engrs, No. 095-D—May, 1906. No. 76107.

The Regulation of High-Pressure Water-Wheels for Power-Transmission Plants. George J. Henry, Jr. Discusses the various devices used for protection and regulation, their advantages and defects. Ills. 4000 w. Am Soc of Mech Engrs, No. 095-C—May 1, 1906. No. 76106.

Laboratory.

The Hydraulic Testing Laboratory of the Worcester Polytechnic Institute. Charles M. Allen. Illustrated detailed description of this plant, which furnishes facilities for a large variety of hydraulic experiments. 2300 w. Eng Rec—March 31, 1906. No. 75883.

The New Hydraulic Laboratory at the University of Wisconsin. D. W. Mead. Illustrated detailed description of this new laboratory and its equipment. 3000 w. Wis Engr—March, 1906. No. 76322 D.

Pipe Conduit.

Designing the 18-Ft. Steel Pipe of the Ontario Power Company, Niagara Falls. Joseph Mayer. Deals with studies in connection with the design of this pipe, its protection against rust and its probable life; its resistance to deformation, its stability, etc. 7000 w. Eng News—April 26, 1906. No. 76339.

Pumping.

See Civil Engineering, Water Supply.

Pump Tests.

A New Method of Measuring Water in Pump Tests. E. H. Birney. Describes a plan adopted in testing a pump, under actual operating conditions, to determine if certain guarantees were fulfilled. Ills. 900 w. Power—May, 1906. No. 76364 C.

Recuperation.

The Recuperation of Waterfalls (La Recuperation des Chutes d'Eau). A. Bernoud. The injector action of the discharge of water through sluices is used to augment the effective head. The plant at Chèvres near Geneva, is described. Two articles. 4000 w. Bull Tech de la Suisse Romande—Feb. 10, March 25, 1906. No. 76264, each D.

Turbine Pumps.

Turbine Pumps with Balanced Impellers. Gives illustrations and test results of two turbine pumps. The main feature is the use of back-to-back impellers, supplemented by an arrangement of thrust-chambers. 1800 w. Eng News—April 5, 1906. No. 75949.

Turbines.

A 10,000 H. P. Single-Wheel Turbine at Snoqualmie Falls, Wash. Arthur Giesler. Information of interest and illustrated description of the largest turbine of its type ever built. 3000 w. Eng News—March 29, 1906. No. 75864.

Efficiency Tests of Turbine Water Wheels. William O. Webber. Records a series of consecutive tests under uniform conditions of four water wheels, with the same apparatus, and same observers, to determine the efficiency, and other points of operation. Ills. 2000 w. Am Soc of Mech Engrs, No. 088—May, 1906. No. 76109.

Theory and Computation for Turbines and Centrifugal Pumps (Theorie und Berechnung des Volìturbinen und Kreiselpumpen). Dr. K. Kobes. A review of the discussion of Dr. Lorenz showing the working method of constructing the bucket curves from the formulas. 1200 w. Zeitschr u Ver Deutscher Ing—April 14, 1906. No. 76210 D.

Turbine Design as Modified for Close Regulation. George A. Buvinger. An illustrated discussion of the types of gates now in use for regulation, explaining their action. 2700 w. Am Soc of Mech Engrs. No. 095 E—May, 1906. No. 76108.

Water Power.

The Monopoly of Hydraulic Power in Switzerland (Die Monopolisierung der Schweizerische Wasserkräfte). H. E. Gruner. An exhaustive discussion of the legal and industrial questions involved in the National control of hydraulic power in Switzerland, including the prohibition of the transmission of energy out of the country. Two articles. 6000 w. Schweiz Bauzeitung—March 24, 31, 1906. No. 76250 each B.

MACHINE WORKS AND FOUNDRIES.

Annealing.

The Automatic Annealing of Metals. Illustrates and Describes the Bates-Peard continuous annealing furnace for non-ferrous metals. 1200 w. Ir Age—April 5, 1906. No. 75919.

Boiler Repairs.

Repairing Locomotive and Other Types of Boilers. R. E. M'Namara. Deals with this subject, especially the repairing of water-tube boilers. 2500 w. Boiler Maker—April, 1906. Serial. 1st part. No. 75992.

Boring Mill.

Designing a Boring Mill. A. L. de Leeuw. A critical review of an article appearing in No. 10, of the present volume of this paper. 5500 w. Am Mach—Vol. 29. No. 15. No. 76032.

Castings.

A Crooked Molding Machine Job. F. W. Hall. Describes work on a Paxson-Hall molding machine which had a very crooked pattern. Ills. 3000 w. Am Mach—Vol. 29. No. 17. No. 76333.

Open-Hearth Steel Casting. W. M. Carr. Discusses the manipulation of heats in acid practice. 2300 w. Foundry—April, 1906. No. 75937.

Cold Working.

Practical Notes on Wire Drawing and Cold Rolling (Aus des Praxis der Eisen Zieherei und Kaltwalzerei). Ernst Rolf. Data concerning the behaviour of annealed and unannealed metal in wire-drawing and other cold-working processes. 1800 w. Stahl u Eisen—March 15, 1906. No. 76227 D.

Cupolas.

Recent Examples of Cupola Construction. (Neue Kupolofenanlage). Fr. Greiner. With plans and elevations of cupola construction in recent German foundries, including data as to methods of operation, and performance. 4000 w. Stahl u Eisen—April 1, 1906. No. 76232 D.

Cutters.

Milling Cutters. An illustrated article considering types of plain milling cutters and of side milling cutters. 2500 w. Mach, N Y—April, 1906. No. 75878 C.

Factory Equipment.

The New Mechanical Equipment at the Joseph Campbell Factory, Camden, N. J. Describes a factory for the manufacturers of food stuffs, said to be a model in mechanical equipment, cleanliness, and the elimination of manual handling of all materials. Ills. 3500 w. Eng Rec—April 21, 1906. No. 76328.

Forging.

Forging at the Collinwood Shops. Gives photographs of some of the articles which are being made in these shops of the L. S. & M. S. R. R., with descriptive notes. 1300 w. Am Engr & R R Jour—April, 1906. No. 75852 C.

Foundries.

A Modern Steel Foundry of the Square Type. Illustrated description of the Baldt Steel Co.'s foundry, at New Castle, Del. 2000 w. Ir Age—April 5, 1906. No. 75918.

Foundry Costs. R. W. McDowell. Describes a system intended to meet the requirements of the general foundry, giving forms used for reports. 5500 w. Ir Trd Rev—April 5, 1906. No. 75941.

Modern Foundry Construction. David Townsend. Read before the Philadelphia Foundry Foremen. Considers the essentials of a thoroughly modern shop. 1700 w. Ir Trd Rev—April 12, 1906. No. 76045.

South Altoona Foundries. Begins an illustrated description of the extensive new plant at South Altoona. The present article describes the wheel foundry. 2500 w. Am Engr & R R Jour—April, 1906. Serial. 1st part. No. 75849 C.

The Manufacturers' Foundry Co., Waterbury, Conn. Illustrates and describes a plant for the manufacture of intricate castings. 1800 w. Ir Trd Rev—April 19, 1906. No. 76145.

Hacksaws.

Testing Hacksaws. H. L. Whittemore. An account of the methods used in making the test, with diagrams. 1300 w. Am Mach—Vol. 29, No. 17. No. 76332.

Joints.

Design of a Riveted Joint. Franklin H. Smith. Gives formulas and explanatory notes. 1500 w. Mach, N Y—April, 1906. No. 75877 C.

Lifting Magnets.

Traveling Cranes with Electromagnets for Handling Bar Iron (Laufkran mit Elektromagneten zum Verladen von Stabeisen). Illustrated description of a crane by the Augsburg-Nürnberg Company, showing the use of magnets for handling rolled structural material. 1000 w. Stahl u Eisen—April 1, 1906. No. 76231 D.

Machine Screws.

Report of the Committee on Standard Proportions for Machine Screws, American Society of Mechanical Engineers. Full report, with 14 tables. 3500 w. Am Soc of Mech Engrs, No 085—May, 1906. No. 76112 C.

Metal Cleaning.

Notes on the Cleaning of Work by Means of the Electric Current. H. S. Coleman. Read before the Faraday Society. Reports experiments made, and the results, with cleaning iron and brass articles preparatory to nickel-plating them. 800 w. Electn, Lond—April 13, 1906. No. 76195 A.

Patterns.

Patterns for Heavy Engine Bed. H. J. McCaslin. An illustrated article discussing the different ways a pattern of this nature can be constructed. 4800 w. Foundry—April, 1906. No. 75938.

Portable Tools.

Portable Electric Tools and Their Industrial Application. Andrew Stewart. Considers points in design, and discusses breast drills, large portable tools, magnetic drilling pillars, and the efficiency of small electric tools. Ills. 2400 w. Elect'n, Lond—March 30, 1906. No. 76009 A.

Punching.

Automatic Multiple Punching Machine. A machine for punching the sheets and angles of structural iron work is illustrated and described. 2200 w. Am Mach—Vol. 29, No. 15. No. 76031.

Rolling Mills.

Methods of Driving Rolling Mills. (Antriebsarten von Walzenstrassen). Franz Gerkrath. A comparison of the relative advantages of steam, gas power, and electricity for driving rolling mill machinery. 3000 w. Stahl u Eisen—April 15, 1906. No. 76246 D.

Shops.

Osborn's File and Twist Drill Factories, at Sheffield, England. I. William Chubb. Illustrated detailed description of these plants and their equipment. 4000 w. Am Mach—Vol. 29. No. 14. No. 75944.

Works and Methods of Alfred Herbert, Ltd., Coventry, England. I. W. Chubb. An illustrated article giving information of interest in regard to the methods of these English tool-makers. 3200 w. Am Mach—Vol. 29. No. 15. Serial. 1st part. No. 76033.

Stock Keeping

A Stock-Keeping System for Raw and Finished Stores. F. W. Jessop. With illustrations of store rooms, and a detailed account of the method and system used by the Electric Controller and Supply Company. 3000 w. Engineering Magazine—May, 1906. No. 76275 B.

Time Card.

A Comprehensive Time Card. E. T. Elbourne. Gives a type of card for use with mechanical recorders explaining the advantages. 1400 w. Am Mach—Vol. 29. No. 17. No. 76335.

Tools.

The Development of Machine Tools (Zur Entwicklungsgeschichte der Werkzeugmaschinen). Hermann Fischer. A historical review of the development of modern machine tools, with especial reference to the various forms of milling machines. 3000 w. Zeitschr d Ver Deutscher Ing—March 31, 1906. No. 76202 D.

Valves.

Globe Valve Standards. A. H. Nourse. Gives tables for low-pressure and heavy-pressure valves and handwheels as adopted by the large shipbuilding firms. Ills. 1500 w. Am Mach—Vol. 29. No. 13. No. 75862.

Variable Speed.

List of Cone and Gear Ratios for Variable Speed Drives. W. Owen. Gives tables, with explanation. 1200 w. Am Mach—Vol. 29. No. 17. No. 76334.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Malleable Cast-Iron. Charles H. Day. Reviews the development, especially in the United States, since 1826, and describes the present process of manufacture. 3800 w. Am Mach—Vol. 29, No. 14. No. 75945.

The Constitution of Cast Iron (Ueber die Konstitution des Roheisens) P. Goerens. A metallographical study of the physical structure of cast iron, with reproductions of microphotographs. 4000 w. Stahl u Eisen—April 1, 1906. No. 76230 D.

High Temperatures.

Strength of Mild and Cast Steel at High Temperatures. Reviews the results obtained in a series of tests made by Prof. C. Bach, of Stuttgart. 2000 w. Engng—March 30, 1906. No. 76013 A.

Rivets.

The Resistance of Rivets Placed Hot (Résistance des Rivets après Mis en Place à Chaud) E. Simonot. A record of experimental tests showing the increase in the strength of rivets over that of the original bar when the rivets are used hot. 1200 w. Génie Civil—April 7, 1906. No. 76221 D.

Steel.

The Range in Tensile Properties of a Low Carbon Steel. James E. Howard. Reports tests made at the Watertown Arsenal showing a wide range in tensile strength due to methods of treatment. 800 w. Ir Age—April 26, 1906. No. 76313.

Tool Steel.

A Defective Bar of Tool Steel. C. E. Carson. A study of the cause for the failure of a finished tool from a bar of steel, showing that the steel did not receive sufficient work in drawing the ingot to render the finished bar sound. Ills. 600 w. Ir and St Mag—April, 1906. No. 76039 D.

High-Speed Steel in the Factory. O. M. Becker. Mr. Becker's fifth paper deals especially with the range and adaptability of alloy-steel tools, showing them to be as well adapted for finishing cuts as for roughing. 4500 w. Engineering Magazine—May, 1906. No. 76276 B.

Tubes.

Collapsing Pressures of Bessemer Steel Lap-Welded Tubes Three to Ten Inches in Diameter. Reid T. Stewart. Reports a research undertaken to supply reliable information on the behavior of modern wrought tubes when subjected to fluid collapsing pressure. Ills. 16200 w. Am Soc of Mech Engrs, No. 091—May, 1906. No. 76101 E.

Vaults.

Armor Plate—The Last Answer of the Banker to the Burglar. Traces the development of the use of special material in vault construction, describing the latest vaults, consisting of face-hardened, Harveyized plates from 5 to 16 inches in thickness, so accurately dove-tailed and locked together as to render the construction seemingly proof against any attack. 2700 w. Sci Am—April 21, 1906. No. 76135.

Waterproofing.

Practical Methods of Waterproofing and Fireproofing. Dr. Koller. Gives methods for making textile fabrics and pasteboard incombustible. 1000 w. Sci Am Sup—April 21, 1906. No. 76137.

MEASUREMENT.

Blows.

Effect of a Blow. Alexander W. Moseley and John Lord Bacon. A report of tests made to measure what a blow does to the piece struck. 900 w. Am Soc of Mech Engrs, No. 096—May, 1906. No. 76104.

Centrifugal Stresses.

The Stresses in Rotating Discs of Varying Thickness (Der Spannungszustand in Rotierenden Schreiben Veränderlicher Breite) M. Grübler. A mathematical investigation of the stresses produced in discs operated at high rotative speeds, with especial reference to the wheel of the de Laval steam turbine. 1800 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76207 D.

Liquids.

A New Liquid Measuring Apparatus. George B. Willcox. An automatic device for measuring the brine flowing from a salt well into a salt works. The volume of the brine is determined by its weight. 1500 w. Am Soc Mech Engrs—No. 093. May, 1903. No. 76102.

Metric System.

The Metric System. A review of the recent movement in regard to the adoption of this system in the United States. 3300 w. Am Mach—Vol. 29. No. 15. No. 76035.

The Proposal to Force the Use of the Metric System. H. H. Suplee. A call for continued united action against the enactment of any legislation compelling the enforced use of the metric system of weights and measures, either in the Government service or in private industries, urging that the present freedom of action be continued. 2500 w. Engineering Magazine—May, 1906. No. 76272 B.

Micrometer.

An Electric Micrometer for Measuring the Seventy-Millionth Part of an Inch. Illustrated description of a machine designed by Dr. P. E. Shaw, of England, which is of great importance to scientific investigators. 2500 w. Sci Am Sup—April 7, 1906. No. 75933.

Pyrometer.

A Low Resistance Thermo-Electric Pyrometer and Compensator. Prof. William H. Bristol. Describes a thermoelectric pyrometer adapted for commercial and every day shop use. Also discussion. Ills. 12000 w. Am Soc of Mech Engrs, No. 090—May, 1906. No. 76110 C.

Screws.

Methods of Correcting Inaccuracies of Screw Threads. Illustrates and describes a method applicable to measuring apparatus, dividing machines, and other instruments of precision recently patented by J. E. Storey. 700 w. Mech Engr—April 14, 1906. No. 76196 A.

Seismographs.

Feeling the Earth's Pulse. Reviews some of the theories advanced to explain earthquakes, and gives illustrated descriptions of some of the recording instruments for measuring the disturbance. 4000 w. Sci Am—April 28, 1906. No. 76380.

Seismograph Record of the San Francisco Earthquake. Waldon Fawcett. Describes and illustrates the seismograph in the United States Weather Bureau observatory at Washington, D. C., and its recording of earthquakes. 1000 w. Elec Rev, N Y—April 28, 1906. No. 76395.

Torsion.

Tests on the Torsional Resistance of Bodies of Trapezoidal and Triangular Section (Versuche über die Drehungfestigkeit von Körpern mit Trapezförnigem und Drieckigem Querschnitt). C. Bach. Data and results of torsion tests upon prisms of various sections showing the relation of torsional and tensile strength. 1500 w. Zeitschr d Ver Deutscher Ing—March 31, 1906. No. 76203 D.

Vibrations.

The Sabouret Apparatus for Testing the Vibrations of Rolling-Stock. Illustrated description of an apparatus for recording the vibrations and oscillations of railway rolling-stock. 1500 w. Engng—March 23, 1906. No. 75911 A.

POWER AND TRANSMISSION.

Bearings.

See Marine and Naval Engineering.

Compressed Air.

Motor-Driven Air-Compressor. Illustrates and describes two air-compressors constructed by Messrs. Reavell and Co., Ltd. One to work an air-lift pump; the other to charge the air-reservoirs used in starting the Diesel oil-engine. 1300 w. Engng—April 13, 1906. No. 76301 A.

The Bursting of Metal Chambers Under Internal Air Pressure. L. H. Chandler. Information compiled from records of the Bureau of Ordnance which is applicable to other than torpedo-flasks. Ills. 2800 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76347 H.

Vertical Compound Two-Crank Inter-Cooling Air-Compressor. Detailed drawings, with description of two powerful air-compressors, each driven by a 400 h. p. gas engine. They supply air for various pneumatic tools, and also operate hammers in a smithy and forge. 1500 w. Engng—April 6, 1906. No. 76081 A.

Conveyors.

Cable Conveyors in Mining and Workshop service. (Schwebetransporte in Berg und Hüttenbetrieben). G. Dieterich. A fully illustrated description of the increasing use of conveyors and cableways in mining and manufacturing industries. Serial. Part I. 4000 w. Stahl u Eisen—April 1, 1906. No. 76229 D.

Mail Conveying Apparatus at the New Chicago Post Office Building. Illustrated detailed description of a very complete equipment for the handling of mail. 1500 w. Eng News—April 5, 1906. No. 75950.

Cranes.

Some German Electrically-Operated Cranes. Dr. Alfred Gradenwitz. Illustrates and describes some typical cranes, the electrical part of which was designed by the Siemens-Schuckert works. 1200 w. Sci Am Sup—April 28, 1906. No. 76381.

Rope Drives.

Endless Wire-Rope Drives. William Hewett. A study of the devices used and means of obtaining the best results. Ills. 3000 w. Stevens Ind—April, 1906. No. 76098 D.

Speed.

An Instantaneous Positive Speed Variator. H. F. Noyes. Illustrates a device designed for a small horizontal drilling and boring machine. 700 w. Am Mach—Vol. 29. No. 16. No. 76126.

STEAM ENGINEERING.

Boilers.

Boiler Incrustation. M. Fletcher. Read before the British Columbia Assn. of Sta. Engrs. Discusses scale and the remedies, corrosion, etc. 1500 w. Engr, U S A—April 16, 1906. No. 76128 C.

Condensation.

Experiments on Surface Condensation. James Alexander Smith. An experimental study of the influence of the presence of air in small quantities upon the surface condensation of low-pressure steam. 7000 w. Engng—March 23, 1906. No. 75913 A.

Surface Condensers (Ueber Oberflächenkondensatoren) G. Hagemann. Developing formulas and diagrams for the proportions of condensers and air pumps for the maintenance of a determinate vacuum, in condensing a given volume of steam. 1000 w. 1 plate. Glückauf—March 24, 1906. No. 76239 D.

The Efficiency of Surface Condensers. Prof. R. L. Weighton. Read before the Inst. of Nav. Archts. Gives results from a very extensive series of trials which were of such a character as was thought might prove useful in the designing and proportioning of condensers generally. Ills. 3000 w. Engng—April 13, 1903. Serial. 1st part. No. 76304 A.

Engines.

A Heated Piston Engine. Charles R. King. Illustrated description of an engine built in Belgium and exhibited at Liége International Exhibition, explaining the objects of the steam distribution. 2000 w. Mach, N Y—April, 1906. No. 75876 C.

Erection.

Suggestions for Erecting Engines. Sterling H. Bunnell. General suggestions, with points on setting templates, indicating, adjusting the governor, etc. 2800 w. Power—May, 1906. No. 76367 C.

Feed Water.

Separation of Oil from Feed Water. J. H. Harwood. Discusses methods of treatment for eliminating the emulsified oil from the feed water. 2000 w. Elec Rev, Lond—April 13, 1906. No. 76143 A.

Firing.

Modern Practice for Firing Water Tube Boilers in Large Vessels. H. C. Dinger. Considers the proper conditions of firing, explaining system. 1800 w. Marine Engng—April, 1906. No. 75860 C.

Fuel Testing.

Coal Testing. John Holliday. Abstract from a paper read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses briefly the various methods of testing and a number of the instruments devised for making tests, and properties affecting the value of coal. 4500 w. Col Guard—April 13, 1906. No. 76197 A.

Pipes.

A Dangerous Steam Pipe. W. H. Wakeman. An arrangement for a large and small boiler in a battery for supplying steam to run an engine is shown, and its danger explained. 500 w. Power—May, 1906. No. 76363 C.

Smoke.

The Prevention of Smoke. Albert A. Cary. Condensed from an address before the N. Y. Sec. of the Soc. of Chem. Ind. Gives suggestions for preventing smoke, discussing the required intelligence in the boiler room, the design of grate, and the design of the furnace. 4000 w. Eng Rec—April 21, 1906. No. 76329.

Steam Consumption.

Steam Consumption of Winding Engines. Reports a trial of an isolated hoisting plant at the Ferriera mine,South Africa, made to determine whether the winding engine was subject to greater condensation losses than the ordinary continuous running engine, and also to discover what economy was effected by the use of trip valves. 3000 w. Engr, Lond—April 13, 1906. No. 76308 A.

Turbines.

Launch of the First American Built Turbine Steamship. An illustrated account of the launch of the "Governor Cobb," at Chester, with information concerning other turbines building. 1800 w. Naut Gaz—April 26, 1906. No. 76388.

Progress Made in the Application of the Parsons Turbine to Marine Propulsion. R. J. Walker. Briefly outlines the development of the turbine as an engine now used extensively for generating electricity and other uses, especially discussing its application to marine propulsion. 5500 w. Marine Rev—April 26, 1906. No. 76387.

Tests of a Curtis Marine Turbine. W. G. Diman. Describes the turbine and reports tests made in Brooklyn, N. Y. to determine the amount of steam used per brake horsepower at different revolutions per minute, and with steam varying in quality from saturated to about 50° F., superheat. 3000 w. Tables and diagrams. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76351 H.

The Application of Steam Turbines to the Propulsion of Vessels (L'Application des Turbines à Vapeur a la Propulsion des Navires). G. Hart. A very complete review of the applications of turbines of various types to steamships with tabulated details of 22 turbine-propelled boats of all classes. 15000 w. 2 plates. Mem Soc Ing Civ de France—Jan. 1906. No. 76234 G.

The History and Development of the Steam Turbine. Harry Y. Haden. The present number reviews the history of the steam turbine from its first conception. Later article will describe the various types in service at present. Ills. 1700 w. Jour of Elec—April, 1906. Serial. 1st part. No. 75999 C.

The Utilization of Exhaust Steam in the Low-Pressure Turbine in Mining Plants (Verwertung des Abdampfes in Niederdruck-Turbinen-Anlagen auf Bergwerken). H. Hundt. Illustrated description of various installations of the Rateau steam accumulator for regulating the flow of exhaust steam for use with a low pressure steam turbine. 4000 w. Glückauf—March 17, 1906. No. 76238 D.

Valve Gears.

Strength and Resistance Conditions in Marine Valve Gears (Kraft und Festigkeits-Verhältuisse bei Schiffsmaschinen Steuerungen). Arthur Pröll. An examination of the link motion and of various radial valve gears, showing the frictional and inertia resistances, and the consequent proportions of the various members. Serial. Part 1. 3000 w. Schiffbau —April 11, 1906. No. 76262 D.

MISCELLANY.

Aeronautics.

How to Make a Gliding Machine. Livingston Wright and Gordon Johnson. Directions with working drawings. 1000 w. Sci Am Sup—April 28, 1906. No. 76384.

The Perfecting of the Aeroplane Flying Machine. Livingston Wright. Discusses the system of control worked out by the Wright brothers, and briefly reviews the work of other investigators. 1400 w. Sci Am Sup—April 7, 1906. No. 75932.

The Wright Aeroplane and Its Performances. An illustrated article on the success of the Wright brothers with their gliding machine in its improved form, with reports from eye-witnesses of the performance. 2000 w. Sci Am—April 7, 1906. No. 75927.

The Wright Brothers Flying Machine and What It Has Accomplished. A communication from Messrs. Orville and Wilbur Wright, to the Aero Club of America, giving details of the development of their motor-driven aeroplane. Also a letter to the Aeronautical Society of Gt. Britain and a short account of Santos Dumont's helicoptere. 2200 w. Sci Am Sup—April 7, 1906. No. 75931.

Drying.

The Art of Drying. George Wetmore Colles. Discusses its application to manufacturing processes, the systems, the types of dryers, etc. 3800 w. Stevens Ind—April, 1906. No. 76099 D.

MINING AND METALLURGY

COAL AND COKE.

Bituminous.

Great Lakes Coal Company. John Leggett Pultz. Illustrates and describes mines at Kaylor, near Pittsburg, which are large producers of bituminous coal. 1300 w. Eng & Min Jour—April 7, 1906. No. 75994.

Briquettes.

Briquetting of Fuels and Minerals G. J. Mashek. Illustrated description of the Zwoyer Fuel Company's process and the New Jersey Briquetting Company's plant. 1600 w. Ir Age—April 19, 1906. No. 76097.

Some Notes on Fuel Briquetting in America. Clarence M. Barber. Read before the Detroit Engng. Soc. Considers the materials used, methods of manufacture, presses, etc. 3000 w. Sci Am Sup —April 7, 1906. No. 75929.

China.

The Coal Fields of China. L. Ramakers. Information concerning the different fields and their characteristics, costs of mining, transportation, etc. 1700 w. Mines & Min—April, 1906. No. 75970 C.

The Hsüan Hua Coal Fields, China Noah Fields Drake. Maps and descriptions of three coal beds and the mines. 3500 w. Min Mag—April, 1906. No. 76042 C.

Classification.

The Classification of Coals. Dr. Persifor Frazer's contribution to the discussion of the paper by Marius R. Campbell. 2700 w. Bul Am Inst of Min Engrs—March, 1906. No. 76121.

Coal Fields.

Coal-Field Exploration. Thomas W. Keighley. Read before the Coal Min. Inst. of America. Describes methods of examination and sampling and the equipment needed by a coal expert. 2200 w. Mines & Min—April, 1906. No. 75972 C.

Coal Handling.

Coal Handling in the Chicago Subway. An illustrated description of the arrangements that have been made for the delivery of coal through the freight tunnels. 2300 w. Eng Rec—March 31, 1906. No. 75881.

Coal Supplies.

Coal Conservation, Power, Transmission, and Smoke Prevention. Arthur J. Martin. Considers the probable duration of England's coal supplies, the wastefulness of present methods, possible economics, electrical and gas transmission, etc. General discussion. 14000 w. Jour Soc of Arts—March 30, 1906. No. 75962 A.

Coke.

By-Product Coke Oven Plant at Camden, N. J. C. G. Atwater. Outlines the plan and construction of the original plant at Camden, N. J., and gives an illustrated detailed description of recent additions. 4800 w. Pro Age—April 2, 1906. No. 75866.

Colliery Equipment.

The Equipment of a Modern Colliery. F. W. Hardwick. Lecture before the Nat. Assn. of Colliery Mgrs. Discusses the choice of site, size of shafts, surface plant, sinking plant, winding engines, etc. Diagrams. 12000 w. Ir & Coal Trds Rev—April 6, 1906. No. 76086 A.

Electrical Equipment.

Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Company. C. P. Sparks. Illustrated description of the equipment of this group of collieries, 20 miles north-west of Cardiff. 2000 w. Col Guard—March 30, 1906. Serial. 1st part. No. 76011 A.

Indian Territory.

Coal Mining in the Indian Territory. W. R. Crane. Describes mining methods where the coal and associated strata are more or less disturbed, and faults and folds, weak roof, much gas, and considerable water must be contended with. Ills. 2800 w. Eng & Min Jour—April 7, 1906. No. 75996.

Lignite.

Simpson Mine. E. D. Rust. Illustrated description of a large and well equipped lignite mine at Lafayette, near Denver, Colo. 2000 w. Mines & Min—April, 1906. No. 75963 C.

Rescue Appliances.

Rescue Appliances in Collieries. Gives illustrations of types of safety appliances, with descriptive notes, and information concerning experiments made in England. 2200 w. Col Guard—March 30, 1906. No. 76012 A.

The Fleuss-Davis Self-Contained Breathing Apparatus. Illustrated description of this recently improved apparatus. The principle is the regeneration of exhaled breath in a special reservoir carried by the wearer, by passing it through caustic soda and simultaneously renewing the supply of oxygen. 1500 w. Engng—April 13, 1906. No. 76300 A.

Sprinkling Plant.

Safety Arrangements for the Prevention of Colliery Fires and Explosions of Fire-Damp in German Coal Mines. Illustrates and describes one of the sprinkling plants used in the Westphalian coal mines. 900 w. Ir & Coal Trds Rev—March 23, 1906. No. 75915 A.

COPPER.

Alaska.

The Copper River District. L. A. Levensaler. Describes the copper deposits and the mines of this district. Gold, silver and other metals are associated. 2000 w. Cal Jour of Tech—Feb., 1906. No. 75961 C.

Assay.

The Quincy Mine Assay Office. C. W. Macdougall. Describes in detail the methods of determining the percentage of copper in waste sands, and other mineral deposits. 2000 w. Eng & Min Jour—April 7, 1906. Serial. 1st part. No. 75995.

Lake Superior.

Copper Mining on Lake Superior. J. Parke Channing. An illustrated account of recent development. 2000 w. Min & Sci Pr—March 24, 1906. No. 75847.

On the Ancient Copper Mines of Lake Superior. Alvinus Brown Wood. Description of an ancient pit on the Quincy mine location. 3300 w. Bul Am Inst of Min Engrs—March, 1906. No. 76120.

Mexico.

Growth of the Copper Industry in Mexico. Information concerning the mines, production, etc., showing Mexico to be the second largest of the world's producers. 1000 w. Min Rept—April 12, 1906. No. 76058.

Mount Morgan.

The Mount Morgan Mine. An illustrated description of recently completed copper treatment works at this mine in Queensland. 3000 w. Queens Gov Min Jour—Feb. 15, 1906. No. 75892 B.

New South Wales.

Great Cobar Copper Mine (N. S. W.). C. H. Cropper. Read before the Sydney Min. Engng. Soc. Describes and illustrates the working and timbering the stopes. 1700 w. Aust Min Stand—March 14, 1906. No. 76092 B.

Secondary Enrichment.

The Secondary Enrichment of Copper-Iron Sulphides. Thomas T. Read. Reviews the opinions advanced by various writers, and reports results of experimental work made to imitate natural conditions. 2500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76122.

Smelting.

Estimation of Copper by Titration with Potassium Cyanide. Describes this method and some of its working details, as used in the laboratory of one of the largest Montana smelters. 1500 w. Eng & Min Jour—April 21,1906. No. 76162.

The Arizona Smelting Company's Plant in Yavapai County, Arizona. Illustrates and describes a plant comprising both copper and lead smelting works, and a concentrating plant of 400 tons capacity. 2400 w. Min Rept—March 29, 1906. No. 75869.

Virginia.

The Virginia Copper Deposits. Walter Harvey Weed and Thomas Leonard Watson. Gives the results of an examination of these deposits, and a microscopic study of the rocks and ores. Ills. 6000 w. Ec Geol—Feb., 1906. No. 75840 D.

GOLD AND SILVER.

Alaska.

Recent Publications on Alaska and Yukon Territory. Alfred Hulse Brooks. A discussion of the literature dealing with this region, that has appeared during the past six months. The metalliferous deposits are first discussed; followed by a brief summary of the literature on the coal fields. 6500 w. Ec Geol—Feb., 1906. No. 75842 D.

Arizona.

Revival of Gold Mining in the Clifton-Morenci, Arizona District. This district in 1905 ranked second among the copper producing sections of the territory, and now a number of the properties are producing gold. Reports developments. 2200 w. Min Rept—April 19, 1906. No. 76175.

Assaying

The Assay of Cyanide Solutions. William Magenau. Describes a method for rapid determination of gold in cyanide solutions; also gives a summary of other methods. 2800 w. Min & Sci Pr—April 14, 1906. No. 76179.

British Columbia.

Mining and Milling at Ymir. D'Arcy Weatherbe. Describes deposits of gold and silver ore, the method of mining, and the treatment of the ore. 1200 w. Min & Sci Pr—March 24, 1906. No. 75848.

The Le Roi, Centre Star, and War Eagle Mines. D'Arcy Weatherbe. Describes these mines in British Columbia and their development. Gold, silver and copper. 2000 w. Min & Sci Pr—March 31, 1906. No. 75975.

Windy Arm Mineral Locations. W. F. Robertson. A report of mineral discoveries near the boundary line between British Columbia and Yukon Territory. Astonishingly high assays are reported, running as high as 800 oz. in silver, and $20 in gold to the ton. Map and Ills. 2500 w. Eng & Min Jour—April 14, 1906. No. 76055.

California.

The Central Mill of the North Star Mines Company. A. D. Foote. Illustrations with description of this fine new stamp mill at Grass Valley, Cal., and a statement concerning some features which have proved undesirable. 1000 w. Min & Sci Pr—April 7, 1906. No. 76060.

Cyanide.

The Cyanide process for Gold and Silver Ores. M. B. Parker. In the *Bul. of the International Miners' Assn.* Discusses its application to ores to which it was formerly considered unsuited. 2400 w. Mines & Min—April, 1906. No. 75964 C.

Extraction

Hydraulic Dredging. F. Danvers Power. Illustrates and describes this method of working alluvial ground, as practiced in Australia, stating its advantages. 1800 w. Eng & Min Jour—April 21, 1906. No. 76265.

Gold Dredges.

New Zealand Gold Dredges. Illustrated description of Watt & Nisbet's dredge-bucket system, and a dredge "Knewstubbs" system for the restoration of agricultural lands. 1000 w. Eng & Min Jour—April 14, 1906. No. 76056.

Idaho.

The Dollarhide Mine, Idaho. Arthur Lakes. Describes the topography of this region, and the location of the mine. The ore is silver bearing galena, mingled with rozin zinc blende and occasionally a little gray copper. 1600 w. Ills. Min Wld—April 7, 1906. No. 75977.

Mexico.

El Oro, the Premier Gold Camp of Mexico. T. Elliott Smith. Description and historical account of this mining region and its development. 4500 w. Min Wld—March 31, 1906. No. 75872.

Nevada.

The Geology and Petrography of the Goldfield Mining District, Nevada. Sketch maps with a description of the geology and topography by John B. Hastings, and of the petrography by Charles P. Berkey. 4500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76124 C.

The Southern Klondike District. Esmeralda County, Nevada.—A Study in Metalliferous Quartz Veins of Magmatic Origin. Josiah Edward Spurr. Describes the occurrence in the Southern Klondike camp proper, giving detailed description of rock types, metalliferous veins, general conclusions, etc. 4300 w. Ec Geol—Feb., 1906. No. 75844 D.

Ore Treatment.

Milling vs. Smelting in the Treatment of Tonopah-Goldfield Ores. Francis L. Bosqui. Considers that these ores may be more profitably milled than smelted. 1000 w. Min & Sci Pr—March 31, 1906. No. 75973.

Slimes

Slime Treatment at Mount Bobby. John M. Bridge. Read before the Sydney Min. Engng. Soc. Describes the filter press method of treatment. Ills. 1500 w. Aust Min Stand—Feb. 28, 1906. Serial. 1st part. No. 76010 B.

Supply.

The Increasing Gold Supply. Editorial on the effect of the increasing supply on the price of materials, cost of labor, and rates of interest. 1000 w. Mines & Min—April, 1906. No. 75969 C.

Tanks.

Iron vs. Wood for Cyanide Leaching Tanks. Francis L. Bosqui. States facts helpful in determining which type is best to use in a given locality. Also reports tests of redwood for the loss of gold by absorption. 900 w. Min & Sci Pr—April 14, 1906. No. 76177.

IRON AND STEEL.

Blast Furnaces.

Dust as a Cause of Wear in Shafts of Blast Furnaces (Gichtstaubals Ursache der Schachtzerstörung in Hochöfen). B. Osann. Notes on the corrosive and erosive action of dust upon furnace linings. 1500 w. Stahl u Eisen—March 15, 1906. No. 76228 D.

Interactions Between Iron and Carbon in the Blast Furnace. Discusses experimental investigations of the pressures and temperatures affecting the mutual actions of iron and its oxides with carbon and its oxides. 1000 w. Engng—April 13, 1906. No. 76198 A.

The Determination of the Profiles of Blast Furnaces (Die Berechnung des Hochofenprofils und ihre Grundlegenden Werte). Bernard Osann. A study of the principles governing the shape of the shafts of blast furnaces according to the nature of the ore and method of working. 4000 w. Stahl u Eisen—April 15, 1906. No. 76245 D.

Classification.

The Classification of Iron by its Molecular Structure (Ueber die Beurtielung des Eisens aus seinem Kleingefuge). Max Kralupper. A study of the effect of heat treatment upon the quality of iron, and the practicability of grading irons by metallographical methods. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 31, 1906. No. 76242 D.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Gas Firing.

The Kurzwernhart Gas-Saving Process. Joseph Hartshorne. Gives the results obtained from this process, together with the objections which have been urged against it, and the answers to them. Ills. 3800 w. Bul Am Inst of Min Engrs—March, 1906. No. 76119.

History.

The Early Use of Iron. Bennett H. Brough. Abstract of a lecture delivered before the West of Scotland Ir. & St. Inst. Gives a brief summary of the results of researches which have thrown light on this subject and reviews existing knowledge of the metallurgy of iron and steel before the introduction of the blast furnace. 1500 w. Ir & Coal Trds Rev—March 30, 1906. No. 76021 A.

Iron Ore.

Iron Ore Reserves. Charles Kenneth Leith. Discusses estimates that have been made of the world's supply of iron ore, its rate of depletion, etc. 2800 w. Ec Geol—Feb., 1906. No. 75843 D.

Iron Industry.

See Industrial Economy.

Metallography.

The Metallography of Iron in England. (Die Metallographie des Eisens in England). Dr. H. Wedding. A review of the work which has been done by British metallurgists and metallographists, with reproductions of microphotographs showing the different physical constituents of iron alloys. 3500 w. Stahl u Eisen—April 15, 1906. No. 76247 D.

Ontario.

Iron Ore in Ontario. Phillips Thompson. Notes from reports dealing with different areas where iron ore is known to occur, describing the deposits. 1800 w. Eng & Min Jour—April 14, 1906. No. 76057.

Phosphoric Irons.

On the Manufacture of a High-Class Steel from Phosphoric Irons. William Galbraith. Discusses the possibility of making a high-class steel from these ores by some modification of the basic process. 1300 w. Ir & Coal Trds Rev—March 23, 1906. No. 75914 A.

Rolling Mills.

Jones & Laughlin New No. 14 Structural Mill. Description, fully illustrated, of the largest rolling mill in the world, and an account of its rapid construction at Pittsburg. 2000 w. Ir Trd Rev—April 26, 1906. No. 76331.

Rolling Mill Drive Construction. Illustrations of old and new designs of pinions, spindles, couplings, etc., reproduced from an article by H. Ortmann in *Stahl und Eisen.* 1700 w. Ir Age—April 12, 1906. No. 76022 A.

Steel

Uses of Steel Versus Wrought Iron. Thomas Lace. Favors the use of open-hearth steel and calls attention to the short-comings of wrought iron. 2500 w. Am Mfr—April 15, 1906. No. 75940.

Steel Works.

German Steel Works and Rolling Mills. Henry Crowe. Abstract of a paper read before the Cleveland Inst. of Engrs. Short descriptions of various works visited. 2500 w. Ir & Coal Trds Rev—April 13, 1906. Serial. 1st part. No. 76310 A.

See also Mechanical Engineering, Materials.

MINING.

Accidents.

Catastrophes and Accidents in Mines

(Les Catastrophes et Accidents de Mines). H. Schmerber. A study of causes of the various kinds of disasters in mining operations, with possible warnings and methods of fighting them; with especial reference to the disaster at the Courrières colliery. 3500 w. Génie Civil—March 31, 1906. No. 76218 D.

Bore Holes.

The Alignment of Deep Bore Holes (Ueber Tiefbohrlochs-Lotapparate). F. Freise. Describing electrical and mechanical devices for insuring the maintenance of the vertical direction in drilling deep bore holes for mining and prospecting work. Serial. Part 1. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 7, 1906. No. 76244 D.

Disaster.

The Courrières Mine Disaster (Das Grubenunglück von Courrières). Fritz Schreyer. A general account of the catastrophe of the Courrières mine, discussing the conditions leading to the flow of gas and consequent explosion. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 7, 1906. No. 76243 D.

Drilling.

The Relative Merits of Large and Small Drilling-Machines in Development Work. Frederick F. Williams. Discusses the relative merits of the large 3⅛-inch. machine and the small 2¼-in. tappett machine in driving development-headings. 1500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76123.

Earth Temperatures.

Earth Temperatures on the Witwatersrand Goldfields. Hugh F. Marriott. Abstract of a paper read before the Inst. of Min. & Met. A record of an investigation of earth temperatures and their relation to deep coal mining in the locality. 2200 w. Col Guard—March 23, 1906. No. 75904 A.

Firedamp.

A Study of Firedamp and the Protection of Electric Machinery. (Versuche mit Schlagwettern und dem Schlagwetternschutz Elektrischer Antriebe). Dr. H. Hoffman. A review of the investigations of Baum. Beyling, and others, upon the best methods of preventing the ignition of mine gases from electric machinery. Two articles—8000 w. Zeitschr d Ver Deutscher Ing—March 24, 31, 1906. No. 76201 each D.

Garnet Zones.

On the Formation of Garnet Zones at the Contacts of Eruptive Rocks and Limestones. James F. Kemp. A study of these zones, explaining the essential points which geologists have worked out regarding them. 3500 w. Min & Sci Pr—March 31, 1906. No. 75974.

Hauling.

European Mining Locomotives. Frank C. Perkins. Illustrations and descriptions of some types of electric, compressed air, and gasoline locomotives for use in mines. 1200 w. Mines & Min—April, 1906. No. 75965 C.

The Operation of Mine Locomotives (Betriebsergebnisse bei den Vörderung mit Gruben lokomotiven). S. Schauberger. Describing the use of gasoline and compressed-air locomotives for underground hauling, with data as to the cost of operation. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 31, 1906. No. 76241 D.

Head-Frames.

Head-Frames. W. R. Crane. On the principles of construction as illustrated by frames constructed at various mines. Ills. Gives also a list of papers and illustrations of head-frames and tipples, and a table of data. 4500 w. Mines & Min—April, 1906. No. 75968 C.

Mine Fires.

Extinguishing a Mine Fire. Lewis T. Wright. An address delivered before the Mining Conference describing a fire occurring in the Iron Mountain mine, Shasta County, California, and how it was extinguished. 1500 w. Cal Jour of Tech—Feb., 1906. No. 75960 C.

Natal.

Natal's Mineral Prospects. Ralph Stokes. Reviews the condition of the mining industry, reporting the output of coal, and unimportant deposits of gold and of copper. 2000 w. Min Wld—April 7, 1906. No. 75978.

Pumps.

Compressed Air Pumps with Water-Heated Reheater. L. C. Bayles. Illustrates and describes an improvement made at the Givern mine, California. 500 w. Eng & Min Jour—April 21, 1906. No. 76161.

Rock Drills.

Air-Hammer Rock Drills. E. A. Rix. Read at Convention of California Miners' Assn. Describes a new type of rock drill for mining work, the kinds of work to which they are suited, and results. 5000 w. Mines & Min—April, 1906. No. 75967 C.

Safety Device.

The Nicholson Automatic Engine-Stop. R. H. Nicholson. Illustrates and describes a mechanical arrangement to prevent overwinding. 900 w. Eng & Min Jour—April 21, 1906. No. 76163.

Shafts.

Notes on the Sinking of a Deep-Level Shaft. F. W. Girdler-Brown. Gives figures covering the cost of a deep level shaft, briefly discussing the rationale of some of the methods employed. 4 schedules. 4800 w. Jour S African Assn of Engrs—Feb. 3, 1906. No. 75939 F.

Re-Sinking and Repairing a Collapsed

Shaft. E. Nelson. Read before the Nat. Assn. of Colliery Mgrs. Illustrates and describes the methods employed to overcome the difficulties. 2000 w. Ir & Coal Trds Rev—March 30, 1906. No. 76020 A.

Silesia.

Mining and Railway Development in Upper Silesia (Bergbau und Eisenbahnen in Oberschlesien). Ober-Baurat Nitschmann. With map of the coal district and a general railroad and mining map. Silesia is rich in coal, iron, lead zinc, and silver. Discussion. 3500 w. Glasers Annalen—April 15, 1906. No. 76260 D.

Snowslides.

Snowslides in the Mining Districts of Idaho. Prof. Arthur Lakes. Discusses their causes and disastrous effects, and how to avoid them. Ills. 2000 w. Mines & Min—April, 1906. No. 75966 C.

The Effect of a Snowslide. Stephen L. Goodale. An illustrated account of the snowslide on March 17, 1906, which demolished a large portion of the stampmill of the Camp Bird, at Ouray, Colo. 700 w. Min & Sci Pr—April 14, 1906. No. 76178.

Tunnels.

The Newhouse Tunnel. George W. Dutton. A description, with illustrations, and general information concerning this work. 1600 w. Min Wld—April 21, 1906. No. 76180.

Winding.

Electric Main Winding Plant for a Shale Mine. Illustrated description of a plant at Cobbinshaw pit, about 15 miles from Edinburgh. 2000 w. Engng—March 30, 1906. No. 76014 A.

Electric Winding Considered Practically and Commercially. Gerald Hoogwinkel. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. A contribution to the discussion of the paper by W. C. Mountain. Also general discussion. 6000 w. Col Guard—March 23, 1906. Serial. 1st part. No. 7590[illegible] A.

Over-Winding in Hoisting Operations. Robert Peele. Explains the dangers from over-winding, and discusses the various devices which have been introduced to prevent fatal consequences. Ills. 3800 w. Sch of Mines Rev—Jan., 1906. No. 76385 D.

The Development of Hoisting Appliances (Entwicklung der Aufsetzvorrichtungen). Karl Teiwes. Discussing especially the appliances used in connection with mine hoists for controlling the exact landing position of the cage or platform. 6000 w. Glückauf—March 31, 1906. No. 76240 D.

Winding Ropes. Editorial considering some of the inquiries in regard to winding ropes made by a Commission appointed by the Transvaal Government to report on the question of safety of persons traveling in shafts. 6800 w. Min Jour—March 24, 1906. No. 75906 A.

MISCELLANY.

Lead and Zinc.

Lead and Zinc Deposits of the Virginia-Tennessee Region. Thomas Leonard Watson. A summary of the results obtained from a study of the geology of the ore-deposits of this district. 13800 w. Ills. Bul Am Inst of Min Engrs—March, 1906. No. 76117 D.

Manganese.

The Principal Manganese Deposits of the World (Les Principaux Gisements de Manganèse du Globe). Ch. Dantin. A review of the manganese deposits in various parts of the world, with the constitution of the minerals and estimates of the quantities. 2000 w. Génie Civil—March 24, 1906. No. 76215 D.

Mercury.

The Mercury Mining District of Monte Amiata, Italy. Vincenzo Spirek. Gives the location and describes the deposits, method of working, production, treatment, etc. Ills. 5000 w. Min Mag—April, 1906. No. 76040 C.

Ores.

Sedi-Genetic and Ignes-Genetic Ores. H. Foster Bain. An investigation aiming to obtain a quantitative estimate of the relative importance in ore production of certain major groups of processes. 2800 w. Ec Geol—Feb., 1906. No. 75841 D.

Petroleum.

The Boulder Oil Fields. A. Lakes. Describes this field explaining why this small area is productive, while the same shales at other points never yield a commercial amount. 1200 w. Min Rept—March 29, 1906. No. 75870.

Platinum.

The Best Riffle for Platinum. Dennis H. Stovall. Considers the best riffle for the tailing-flume is steel strapped scantlings. 800 w. Min & Sci Pr—April 7, 1906. No. 76059.

Tin.

Tin Mining and Milling in Tringganu. C. C. Warnford Lock. An illustrated account of the tin mining of Malay peninsula describing the geology of the region, the tin deposits, etc. 1400 w. Min Mag—April, 1906. No. 76041 C.

Zinc.

The Mining, Preparation and Smelting of Virginia Zinc-Ores. Thomas Leonard Watson. Treats of the purely economic phases of the zinc ores of this district. 4500 w. Ills. Bul Am Inst of Min Engrs—March, 1906. No. 76118.

CONDUCTING TRANSPORTATION.

Accidents.

Accidents to Servants on American and British Railways. A comparison showing much better conditions in England than in America. 2400 w. Engr, Lond—March 30, 1906. No. 76017 A.

Floods.

Flood Damages, N. W. R., India. G. H. List. An illustrated account of some of the railway disasters caused by floods, especially describing the destruction of the Pulku-Nala bridge. 1800 w. Engr, Lond—April 6, 1906. No. 76083 A.

Gould Railways.

The Gould System. Gives a brief outline of the history prior to 1901, and treats in greater detail the events of the last five years, showing the development, and discussing the outlook. 2200 w. R R Gaz—April 20, 1906. No. 76149.

Standard Code.

Suggested Changes in the Standard Code. H. A. Dalby. Gives suggestions with explanations of why the changes are recommended. 5500 w. Ry Age—March 30, 1906. No. 75868.

Train Control.

The Powell-Potter System of Automatic Control of Trains. Benton C. Rowell. From an address before the Nat. Assn. of Ry. Com., at Washington. An explanation of the system and its operation. 7000 w. Ry & Engng Rev—April 7, 1906. No. 75976.

MOTIVE POWER AND EQUIPMENT.

Boiler.

Riegel Water Tube Locomotive Boiler. Illustrates and describes a new design. 1200 w. Am Engr & R R Jour—April, 1906. No. 75851 C.

Brakes.

Advancement and Improvements in Air-Brakes. Walter V. Turner. Abstract of a paper read before the Cent. Elec. Ry. Assn. Aims to show that improvements in the system have kept pace with the development of locomotion. Explains some features introduced. 3500 w. St Ry Rev—April 15, 1906. No. 76063 C.

Kapteyn's Apparatus for Testing Continuous Brakes (Kapteyn's Prüfvorrichtung für Versuche mit Durchgehenden Bremsen). A. Führ. The successive action of the brake cylinders is recorded by pressure indicators on a moving band of paper. 2000 w. Glasers Annalen—April 1, 1906. No. 76259 D.

Test of the Sauage Air Brake. George L. Fowler. Illustrates and describes this arrangement and its action, reporting the tests made. 5500 w. R R Gaz—April 6, 1906. No. 75956.

Cars.

The Six-Axle Cars of the International Sleeping-Car Company (Voitures à Six Essieux de la Compagnie Internationale des Wagons-Lits). Illustrating the new dining cars and compartment sleeping cars of the International Company, fitted with six-wheel bogie trucks at each end. Special details of the trucks are shown. 1800 w. 1 plate. Génie Civil—March 31, 1906. No. 76216 D.

Car Department Control. F. Lincoln Hutchins. Discusses the fundamentals of car department management, how to make the records, and how to make them show the actual performance. 3500 w. Ry Age—April 20, 1906. No. 76168.

The Betts Car Reporting System. Describes this new system used in making up accurate car records, recently installed in the Chicago North-Western Ry. Gives blanks used. 1200 w. R R Gaz—April 27, 1906. No. 76379.

Third-Class Carriage for the Belgian State Railways. Illustrated description. 600 w. Engng—April 6, 1906. No. 76079 A.

Electric Traction.

See Street and Electric Railways.

Explosion.

Explosion of a Locomotive Boiler near the Saint-Lazare Station, Paris. Robert Dubois. Gives general information, description of the engine, and methods of investigation, with many illustrations. 6800 w. Bul Int Ry Cong—March, 1906. No. 76361 E.

Liquid Fuel.

Locomotive Firing with Liquid Fuel. A. S. Atkinson. Describes the arrangements for the general use of oil as a fuel in Southern California, and discusses the important factors favoring the use of oil for locomotive firing. 2500 w. Boiler Maker—April, 1906. No. 75991.

Locomotive Failures.

A Ten Years' Record of Locomotive Failure. Gives some results of a careful study made of locomotive casualties on an English road, covering ten years. 1500 w. Am Engr & R R Jour—April, 1906. No. 75854 C.

Locomotives.

Consolidation Locomotive for the Boston & Maine. Illustrations, principal dimensions, and particulars of 2-8-0 locomotives with Walschaert valve gear. 300 w. Ry Age—April 20, 1906. No. 76167.

Culm Burner for the D., L. & W. Illustrated description of engines with the Wootten type of wide firebox. 600 w. Ry & Loc Engng—May, 1906. No. 76376 C.

Details of the A. C-D. C. Locomotives for the New York, New Haven & Hartford Railroad. Describes the electric locomotives for operation on the direct-current division between the Grand Central station and Woodlawn, and on the alternating-current portion of its line between Woodlawn and Stamford. Ills. 3000 w. R R Gaz—April 13, 1906. No. 76046.

First Swedish Superheater Locomotive. Dr. Alfred Gradenwitz. Brief illustrated description of the type of apparatus used, and a record of some comparative trials. 1000 w. Ry Age—April 20, 1906. No. 76170.

Mallet Compound Duplex Locomotives for the Guayaquil & Quito Railway. Illustrations with dimensions and notes. 500 w. Eng News—April 12, 1906. No. 76052.

New Atlantic-Type Locomotives. Photograph and particulars of new Atlantic (4-4-2) type express passenger locomotives for the London, Brighton, and South Coast Ry. 700 w. Mech Engr—March 31, 1906. No. 76002 A.

New Compound Express Locomotives; Midland Railway. Charles S. Lake. Illustration, principal dimensions, and particulars of interest. 800 w. Mech Engr—April 7, 1906. No. 76070 A.

Pacific Type Passenger Locomotive. Illustrates and describes some powerful locomotives built for the Southern Railway. 500 w. Am Engr & R R Jour—April, 1906. No. 75853 C.

Recent High-Speed German Locomotives (Neuere Deutsche Schnellzuglokomotiven). M. Michter. Discussing especially the modern four-cylinder compound engine of the de Glehn type, with diagrams of speed performance. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—April 14, 1906. No. 76208 D.

Score: 84 Not Out. Illustrated description of an engine, still at work on the Northeastern Railway of England, which was built in 1822. 1000 w. Ry & Loc Engng—April, 1906. No. 76023 C.

Single Expansion 4-6-2 for the O. S. L. Illustrated description of a Prairie type engine for the Oregon Short-Line. 700 w. Ry & Loc Engng—May, 1906. No. 76373 C.

Ten-Wheel Freight Locomotive for James Bay Railway. Illustration with description of the special features. 1000 w. Can Engr—April, 1906. No. 75921.

The Actual Efficiency of a Modern Locomotive Represented by Work Actually Performed, Compared with the Lighter Locomotives, of Twenty Years Ago. Willian Penn Evans. A comparison between the locomotives of the present and those built twenty years ago, as to efficiency, cost, reliability, etc. 5000 w. Pro Pacific C Ry Club—Feb. 17, 1906. No. 75924 C.

The Cole Four-Cylinder Balanced Compound. G. M. Basford. Reviews an interesting line of development of passenger locomotives showing the progress toward very powerful engines and in the Cole four-cylinder Compound, with illustrations. The advantages of the compound are stated and of balancing. 9000 w. Pro S & S-W Ry Club—Jan., 1906. No. 76093 E.

The Large Locomotive. G. M. Basford. Remarks on the rapid advance in weight and power, their service, efficiency, maintenance, etc. 5000 w. Pro Pacific C Ry Club—Feb. 17, 1906. No. 75925 C.

The latest Great Northern Engines. Charles Rous-Marten. A report of actual work done by these Ivatt locomotives, a compound, and two non-compounds. 2500 w. Engr, Lond—March 31, 1906. Serial. 1st part. No. 76016 A.

The Mellin Compound. Hal R. Stafford. An illustrated description of this two-cylinder compound in its latest form with an outline of the history of this type. 2000 w. Am Engr & R R Jour—April, 1906. No. 75850 C.

Locomotive Tests.

Report of Committee Appointed to Cooperate with the Pennsylvania Railroad System in Conducting Tests of Locomotives at the Louisiana Purchase Exposition. 7200 w. Am Soc Mech Engrs, No. 092—May, 1906. No. 76103 C.

Motor Cars.

Railway Automobiles (Motorlokomotiven). F. Kramer. With illustrations of gasoline and petroleum automobile cars for use on railways, with especial reference to the machines of the Otto works at Deutz, opposite Cologne. 4000 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76205 D.

Pipe Connections.

Diagram of Pipe Connections—"E T" Engine and Tender Equipment. Gives illustrations showing the pipe connections and the internal construction of the various valves, with descriptive notes of the working. 2500 w. Ry & Loc Engng—April, 1906. No. 76024 C.

Power House.

See Electrical Engineering, Generating Stations.

Stay-Bolts.

Stay-Bolt Practice of the Pennsylvania Railroad. Illustrates and describes improvements introduced by A. W. Epright, giving results. 1700 w. Am Mach—Vol. 29. No. 13. No. 75861.

Tractive Power.

Some Slippery Engines. Editorial, explaining the causes of slipping, and showing that, while sometimes the result of design, is always caused when the maximum tractive effort exceeds the frictional limit. 1500 w. Ry & Loc Engng—May, 1906. No. 76374 C.

Valves.

Distributing Valve. Illustrated description of these valves, the internal construction and operation in air brakes. 3000 w. Ry & Loc Engng—May, 1906. No. 76375 C.

NEW PROJECTS.

Alaska.

The Alaska Central Railway. M. S. Duffield. An illustrated article describing the railroad building across Kenai peninsula, and the proposed extension; the character of the country, and matters of interest in regard to its development. 3000 w. Eng & Min Jour—April 21, 1906. No. 76164.

Cuba.

The Railroads of Cuba. An illlustrated description of the railroad system, and account of the companies operating the lines. 1200 w. R R Gaz—April 20, 1906. No. 76154.

Mexico.

The New Railroad for the West Coast of Mexico. E. A. H. Tays. Map and information concerning a railroad to be built from Guaymas, Sonora, southward, probably terminating at Tepic. 3000 w. Eng & Min Jour—April 7, 1906. No. 75997.

PERMANENT WAY AND BUILDINGS.

Coaling Plant.

The Watscka Coal, Ash and Water Plant of the Chicago & Eastern Illinois R.R. A recently built plant, having a number of advantageous features is illustrated and described. 1500 w. Eng Rec—April 14, 1906. No. 76318.

Construction Work.

Construction Work on the Canadian Northwestern Railway System. An illustrated description of the building of this railway, especially the construction work during the past season. 3000 w. Eng News—April 5, 1906. No. 75946.

Curves.

Line and Surface. Moses Burpee. This first of a series of articles, explains the principles governing the properties of curves. 1800 w. Ry & Engng Rev—April 21, 1906. Serial. 1st Part. No. 76171.

Gauges.

The Gauge of Colonial Railways. Information concerning the gauges used in Australia, India and South Africa. 2700 w. Engr, Lond—April 13, 1906. No. 76309 A.

Key West Extension.

Key West Extension of the Florida East Coast. Harry C. Smith. An illustrated article describing the progress and explaining some of the difficulties. 1800 w. R R Gaz—April 20, 1906. No. 76152.

Rail Joint.

Improved Rail Joint for Street Railways (Neue Schienenstossverbindungen für Strassenbahnen). W. Küppers. Describing a form of joint in which an intermediate headpiece of rail is inserted. A portable milling machine is used to finish off the surface of the joint. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—April 6, 1906. No. 76226 D.

Shops.

New Shops of the Missouri, Kansas & Texas Railway, Parsons, Kansas. Illustrates and describes the new plant under construction for repair facilities. 900 w. Ry Age—April 13, 1906. No. 76068.

Signalling.

Automatic Signals in Great Britain and on the Continent. Interesting information concerning the causes that have worked against the introduction of automatic systems. 2500 w. Ry Age—April 20, 1906. No. 76169.

Blake Signals: Their Operation and Uses. E. J. Burke. Abstract of a paper read before the Cent. Elec. Ry. Assn. Explains the uses in detail, and gives general information in regard to the system. 2000 w. St Ry Rev—April 15, 1906. No. 76062 C.

Switches.

The Arrangement of Switches on American Railways (Die Weichen Amerikanischer Eisenbahnen). Dr. Blum & E Giese. Notes of inspection on American railways, with illustrations of switches and frogs used on the Pennsylvania, New York Central, and Illinois Central railroads. 2500 w. Zeitschr d Ver Deutscher Ing—March 17, 1906. No. 76200 D.

Switzerland.

The Davos - Filisur Railway (Die Bahnlime Davos-Filisur). P. Saluz. A description of the new line to connect the Rhaetikon Railway with the interior of the Engardine. Map and profile are given, and details of bridges. 1600 w. Schweiz Bauzeitung—March 24, 1906. No. 76249 B.

Tehuantepec.

The Isthmus of Tehuantepec and Its Inter-Ocean Railway. A report on the construction of a railway across this isthmus, and its possible relation to the Panama Canal. Ills. 2000 w. Sci Am Sup—April 7, 1906. No. 75928.

Terminals.

Railway Terminals on San Francisco Bay. Map, with explanation of the location and topography and the lines now built or under construction. Considers the terminals on the Oakland side of the bay, ferry systems across the bay, and the Southern Pacific terminals in San Francisco. 2000 w. Ry Age—April 20, 1906. No. 76166.

The Transformation of the Railway Station at Lausanne (La Transformation de la Gare de Lausanne). A description of the important extension of the Simplon-Jura station at Lausanne in view of the increased traffic expected upon the opening of the Simplon tunnel. 1500 w. 1 plate. Bull Tech de la Suisse Romande—March 10, 1906. No. 76265 D.

Ties.

Concrete Railroad Ties. G. H. Kimball. Considers the present status of the tie question, giving a practical example of a concrete tie that has withstood the test of time and traffic. Ills. 2000 w. Cement Age—April, 1906. No. 76029.

Metallic Cross Ties (Der Eiserne Oberbau). A review of the possibility of replacing wooden sleepers with some form of metallic tie which shall be commercially and structurally practicable. 3500 w. Stahl u Eisen—March 15, 1906. 76227 D.

Track.

The Deformations of Railway Track (Sur les Déformations des Voies de Chemins de Fer). G. Cuénot. A study of the influence of cross ties of different kinds upon the transversal, vertical and longitudinal movements of the rails. Experiments were made with sleepers of wood, steel, and steel and wood combined. 1200 w. Comptes Rendus—March 26, 1906. No. 76222 D.

Tunneling.

See Civil Engineering, Construction.

Wabash.

Wabash Eastern Improvements. An illustrated article describing improvements at the Wabash-Pittsburg terminal, and at Jewett, Ohio, where the connection is made with the Wheeling & Lake Erie, and other points. 1800 w. R R Gaz—April 27, 1906. No. 76378.

TRAFFIC.

Railroad Rates.

See Industrial Economy.

Statistics.

Traffic Statistics and Freight Train Working. Considers statistics from the working point of view, aiming to show the difficulties in their application, the best methods of handling them, and in what directions improvements may be made. 4000 w. Ir & Coal Trds Rev—March 30, 1906. No. 76019 A.

STREET AND ELECTRIC RAILWAYS

Baltimore

The Reconstructed Baltimore System. An illustrated account of the damage to the system by the fire in Feb., 1904, and the work accomplished in the past two years, which has greatly improved the property and increased its efficiency. 3300 w. St Ry Jour—April 21, 1906. No. 76172 C.

Berlin.

Plans for Reducing the Headway between Trains on the Berlin City Railway (Vorschlage zur Verkürzung der Zugfolgezeit auf des Berliner Stadbahn). W. Wechmann. A discussion of traffic conditions on the Berlin elevated railway, with speed curves and signal systems, showing how the carrying capacity may be increased. 4000 w. Glasers Annalen—April 15, 1906. No. 76261 D.

Boston Subway.

The Washington St. Tunnel of the Boston Subway System. A report of the construction of this new tunnel for the accommodation of the elevated trains. Ills. 4500 w. Eng News—April 19, 1906. No. 76130.

Cable Incline.

The Electric Cable Road at Nancy (Funiculaire Electrique de Nancy). G. E. Bernardet. Describing a cable incline railway from the city of Nancy to Saint Antoine, a resort about 150 feet above. The cable runs continuously driven by electric power, the number of cars being varied to meet the traffic. 4000 w. Mem Soc Ing Civ de France—Jan. 1906. No. 76233 G.

Car Wiring.

Good Wiring Practice on Cars at Washington, D. C. An illustrated description of the scheme of Gordon Campbell for furnishing maximum protection against damage to cars and injury to passengers from electrical causes. 600 w. St Ry Jour—April 21, 1906. No. 76173 C.

Chicago.

The Capacity of Surface Loops for Traffic as Influenced by the Intersecting Lines in the Downtown District of Chicago. W. A. Blanck. Report of an investigation showing that it is impossible to operate more cars on the loop under consideration with the present schedule of speed. 1600 w. St Ry Jour—April 14, 1906. No. 76065 C.

Interurban.

Economic and Financial Phases of Interurban Railways. Guy Morrison Walker. Especially discussing the economic value of railways. 6000 w. Sib Jour of Engng—April, 1906. No. 76389 C.

London.

London Tube Railways Permanent Way. Drawings showing in detail the system in the Baker Street and Waterloo Railway, with explanatory notes. 800 w. R R Gaz—April 20, 1906. No. 76156.

Recent Extensions of the London United Tramways. Illustrated description of the recently opened Surrey extensions, which are the first tramways to cross a Thames bridge. 2200 w. Elec Rev, Lond—April 6, 1906. No. 76073 A.

Main Lines.

Alternating Current Electric System for Heavy Railway Service. B. G. Lamme. Discusses the development in the application of electricity to heavy service, and describes the New Haven single-phase equipment. Discussion follows. Ills. 34000 w. Pro N Y RR Club—March 16, 1906. No. 76091.

Electric Traction for Trunk Lines. Extracts from a report made by K de Kando, to Ganz & Co., on impressions received on his recent trip to America. 3500 w. R R Gaz—April 20, 1906. Serial. 1st part. No. 76155.

Electric Traction on Main Line Railways in Europe. Philip Dawson. A discussion of the electrification of main lines, explaining conditions, comparing the systems of operations available, describing details of equipment, and giving much information. Ills. 9500 w. St Ry Jour—April 7, 1906. No. 75989 C.

Power House.

See Electrical Engineering, Generating Stations.

Sand.

Drying Sand for Sanding Rails in the Borough of Manhattan. W. Boardman Reed. Explains the conditions which cause "bad" rails in the city, and the effects of coarse sand on the wheels and describes the screening and drying of the sharp fine sand used. Ills. 2800 w. St Ry Jour—March 31, 1906. No. 75874 C.

Simplon

Electric Traction on the Simplon Railway. Dr. Alfred Gradenwitz. Information concerning the arrangements being made for the trial runs permitting a comparison between steam traction and electric service. 1000 w. Sci Am—April 7, 1906. No. 75926.

Single-Phase.

Experimental Single-Phase Installations for the Swedish State Railways. Gives a brief illustrated description of the trial equipments for the electric railway experiments in progress. 2000 w. St Ry Jour—March 31, 1906. No. 75873 C.

Single-Phase and Continuous-Current Equipments and Limiting Schedule Speeds. H. M. Hobart. Compares the merits of the two systems pointing out the importance of having ample reserve of capacity for maintaining high accelerating rates in order to obtain the improvement in schedule speed demanded. Diagrams. 2700 w. Tram & Ry Wld—April 5, 1906. No. 76139 B.

Single-Phase Direct-Current Locomotive for the New York, New Haven & Hartford Railroad. An illustrated account of the motor and its construction, with detailed description of this important machine and its operation. Also editorial. 6700 w. St Ry Jour—April 14, 1906. No. 76064 C.

Single-Phase Railway Motors and Methods of Controlling Them. T. H. Schoepf. Abstract of a paper read before the Manchester Local Sec. of the Inst. of Elec Engrs. Short discussion. 1700 w. Elect'n, Lond—March 23, 1906. No. 75902 A.

Subways.

New York Subway and George S. Rice's Views. Extract from an address by the Chief Engineer of the New York Rapid Transit Commission, delivered before the New England Railroad Club at Boston. Also discussion. 3800 w. R R Gaz—April 20, 1906—No. 76153.

The Philadelphia Subway. David Lay. Illustrates and describes new features in concrete construction, tracklaying, and sanitary arrangements. 1500 w. Cement Age—April, 1906. No. 76030.

Ventilating the New York Subway. Editorial review of the recent report of George S. Rice on the investigations of the ventilating problem. 1000 w. Eng Rec—April 7, 1906. No. 75980.

Third-Rail.

Effects of a Sleet-storm on Different Types of Third Rail Protection. Gives illustrations showing the sleet formation on the rail, with the various types of protection. 400 w. R R Gaz—April 13, 1906. No. 76047.

Third Rail Insulators. E. Goolding. Gives plan and sectional elevation of a new form of third rail insulator with descriptions. 1200 w. Tram & Ry Wld—April 5, 1906. No. 76140 B.

Ventilation.

The Condition of the Air of the Rapid Transit Subway. George A. Soper. Abstract of a paper presented before the N. Y. Acad. of Medicine. Reports concerning the temperature, humidity, bacteria, sanitation, dust, and odors. 4000 w. St Ry Jour—March 31, 1906. No. 75875 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
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Gesundheits-Ingenieur. *s-m.* München.
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Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
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Locomotive. *m.* Hartford. U. S. A.
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Marine Review. *w.* Cleveland, U. S. A.
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Mining Reporter. *w.* Denver, U. S. A.
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Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
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Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
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Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Instituts Indicator. *qr.* Hoboken, U. S. A.
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Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
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Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S

CURRENT RECORD OF NEW BOOKS

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History.

Morton Memorial—A History of the Stevens Institute of Technology, Edited by Franklin de Ronde Furman, with an introduction by President Alexander Crombie Humphreys. Size 8 in. by 12 in.; pp. xxiv 641. Price $10. Hoboken, N. J.: Stevens Institute of Technology.

This magnificent volume was originally started by the late President Morton some years before his death with the intention of making it a souvenir of the twenty-fifth anniversary of the founding of Stevens Institute. After the death of President Morton the work was taken in hand by the alumni of the Institute, the plan being so modified as to render it, a memorial to Dr. Morton, as well as a history of the Institute, and in this form it has been completed and issued to such members of the alumni as had subscribed for it.

There being a moderate excess of copies beyond the number necessary to supply the subscribers the committee has decided to offer the remainder of the edition for public sale, so that it has become practicable for a limited number of copies to be placed in the hands of those to whom it would otherwise have been inaccessible, and we believe that we are fully justified in stating that this opportunity will be welcomed to the fullest extent.

The first portion of the book includes a history of Stevens Institute of Technology from its foundation in 1870 to the year 1905, including the construction of the original building and the formation of the original faculty, together with the changes and additions which have been made since that time, including the Carnegie laboratory, and its endowment. This is followed by an account of the engineering achievements of the various members of the Stevens family, covering especially the work of John, Robert L., and Edwin A. Stevens. This section contains much original matter covering the early days of the steamboat, operated by John Stevens on the Hudson River in 1804, and on the ocean for the first time in 1809 by Robert L. Stevens; the steam railroad, operated on a private track in Hoboken in 1826 by John Stevens and in public service as the Camden & Amboy, in 1831; the armored war vessel; and many mechanical devices, such as the present form of rail and spike used on American railroads; the screw propeller; the multitubular boiler; the use of steam expansively, of anthracite coal in locomotives, and many other inventions.

The third section includes biographies of the trustees, faculty, and alumni of Stevens Institute, including complete lists of the writings of Dr. Morton, Professor Thurston, and other eminent members of the faculty. In the biographies of the alumni every graduate is included, with portraits of nearly one-half the number, and many interesting facts about the careers of the men after their graduation.

This work is a most valuable contribution to the engineering history of the United States during the past quarter-century, showing the important part which the graduates of Stevens have taken in the development of the applied science of engineering in all parts of the land, and a copy should be in every important reference library in the country.

Valve-Gears.

Valves and Valve-Gear Mechanisms. By W. E. Dalby. Size 6½ in. by 10 in., pp. xii, 366. Price 21 shillings. London: Edward Arnold. New York: Longmans, Green & Co.

Valve Gears for Steam Engines. By Cecil H. Peabody. Size 6 in. by 9 in., pp. v, 142. Price $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

It is interesting that Professor Dalby's extensive treatise of steam-engine valve-gears should appear about the same time as a new and revised edition of Professor Peabody's book upon the same subject.

and it may be appropriate to notice them at the same time.

As Professor Dalby says in his preface, valve-gear mechanisms have fascinated successive generations of engineers, and yet we have at the present time in practical use three or four groups of such mechanisms upon which engineers have settled as best adapted for steam engines of corresponding types. For stationary engines either the slide valve with its eccentric, or some form of trip or detached valve-gear, is applied; for locomotives either the ordinary link or the Walschaert; and for marine engines the link, or some one of the radial gears; these are the practical departments into which valve gear-design is found to be divided, and this condition of affairs will probably continue to obtain until reciprocating engines are replaced altogether by turbines or other rotating machines, or steam is supplanted by gas.

Professor Dalby limits himself in the present volume to those gears in which there is one, and only one position of the valve for a given position of the crank, thus excluding all of the so-called "detached" gears from analytic discussion, although in a chapter entitled "Independent Valve Gears" a brief description is given of the Meyer, Rider, Corliss, and Sulzer gears. After preliminary chapters, in which the general construction of valves and their operation by a single eccentric are discussed by graphical methods there follows an analytic summary, after which reversing valve gears are treated, following generally the method of Zeuner, but employing the rectangular diagram of Professor Osborne Reynolds. In a chapter on radial gears the Walschaert gear is given particular attention, this being especially welcome in view of the fact that this excellent gear has practically displaced the link motion entirely on the Continent for locomotives, and is rapidly coming into use for the outside cylinders of modern four-cylinder compound engines in England and America.

A very useful chapter is that upon statical and dynamical problems in connection with the design of a valve gear, the increasing dimensions, weights, and speeds in modern practice rendering these points of great importance, especially in connection with valve gears for marine engines.

The text book of Professor Peabody is naturally prepared from a different viewpoint from the preceding volume, being intended rather to give the learner a firm grasp of the principles, together with facility in their application, than to provide a comprehensive mathematical discussion of the whole subject. The Zeuner diagram is used throughout, and analytical discussions are relegated to an appendix.

In the discussion of radial valve gears, Professor Peabody believes that such large irregularities occur in their motions that analytical methods are useless, if not misleading, and instead of endeavoring to give a general method of treatment he confines himself to the direct discussion of a few prominent forms, stating that facility in the design of such motions can be obtained only through experience, an opinion which commends itself to common sense and judgment.

A useful chapter in Professor Peabody's book is that relating to the design of gears with shifting eccentrics, this including the methods used in a number of the so-called single-valve automatic engines which, in the United States at least, form a commercially important portion of the steam engine business. The chapter on drop cut-off valve gears contains a discussion of the Corliss gear of the Reynolds type, together with some treatment of cam gears as used by several American builders.

The illustrations in Professor Peabody's book are all in the form of folding plates, placed in the back of the book, and so arranged that when unfolded the entire illustration may be seen while referring to any portion of the book. This plan, which has its advantages, does not render the volume convenient for general consultation, especially when, as in this instance there are no titles on the plates, other than a reference number.

Biography.

Automobile Biographies. Edited by Lyman Horace Weeks. Size 6 in. by 9 in., pp. 180. Price $2.00. New York: The Monograph Press.

The development of the automobile some time ago reached a stage where the identity of the men engaged in the work became a matter of public interest, and the compilation of this book has met this feeling by providing a series of short biographies of those who have done good work in the design and introduction of mechanically-propelled vehicles. The first portion of the volume relates to the origin and development of the automobile, including the early steam vehicles which preceded and accompanied the development of the railroad, this being followed by a series of biographies, beginning with Cugnot and coming down to Daimler, Levassor, and Serpollet. Many excellent portraits accompany these short sketches, giving a good idea of the personality of the men, while appended is a list of brief notes concerning noted investigators whose work has aided in the development of the automobile.

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"THE WORLD IS ITS FIELD"

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THE PANAMA CANAL. PROJETS OF THE BOARD OF CONSULTING ENGINEERS.

By General Henry L. Abbot.

General Abbot is trebly qualified to discuss his topic with authority—as one of the world's greatest specialists in the hydraulics of rivers, as admittedly the foremost student of the peculiar problems of the Chagres and the Panama Canal in its relation thereto, and as member of the Advisory Board, just dissolved. In view of the particular reasons offered by the majority of the United States Senate Committee for their recommendation of the so-called "sea-level" projet, and of the wide-spread misconception of the bearings which the San Francisco earthquake might have upon the decision in the case, General Abbot's sound analysis and comparison of the two plans is especially timely and certain to be strongly helpful in the final determination of this actively interesting question.—THE EDITORS.

THE most important consideration from an engineering point of view in projecting a transit route, whether it be a railroad or a canal is to adjust the details to the topography and natural conditions of the region to be traversed. On the Isthmus of Panama, the Chagres River is the dominating feature. The canal and river must be near neighbors for about three quarters of the entire distance, and the real problem is to so plan the former as to make it harmonize with the characteristics of the latter in the most perfect manner possible. The deep excavation in the Culebra section is a formidable undertaking, chiefly because it will be necessary to transport the spoil to long distances; but once executed it will remain without giving occasion for anxiety in the future. The Chagres, on the contrary, is capable of becoming a very active enemy at any future time unless effectively tamed by good engineering.

The Board was unable to agree upon a unanimous solution of the canal problem. Two projets were submitted, one of them at sea level with a tidal lock at the Panama end; and the other having a summit level 85 feet above mean tide, created by a dam at Gatun and reached by three locks at that locality, the descent being made by one lock at Pedro Miguel conducting to a second lake 55 feet above mean tide, and thence to the Pacific by two locks at Sosa, near La Boca. Each projet will be briefly considered in turn.

There is no radical difference between them at the two ports of entrance, that on the Colon side being formed by a jetty skirting the shore of Manzanillo Island from a point near the mouth of the Mindi, with a short eastern jetty to suitably narrow the approach. The existing canal entrance is thus left to be used as a locus for depots of supply. On the Pacific side the existing anchorage in the Bay of Panama is reached after passing the locks by dredged channels, as heretofore. The general dimensions of both projets are controlled by the language of the law defining the size of the vessels to be accommodated, which are to be "of the largest tonnage and the greatest draft now in use, and such as may be reasonably anticipated." This requirement has largely increased the dimensions of the waterway contemplated in previous projets. The size of the commercial vessels engaged in general traffic is regulated by the depth available in the important commercial ports of the world, while that of the modern leviathans is limited only by the exceptional depths existing in the great ports between which alone they are designed to ply. The capacity of the new projets thus not only greatly exceeds that afforded by any existing ship canal, but also largely discounts future demands for increased facilities.

Both these projets also differ in another important element from those which have preceded them. The cut at the Culebra section, below the top of the indurated argillaceous schist, is projected by the board on a general slope of 3 on 2 instead of 1 on 1 as adopted both by the New Panama Canal Company and by the Isthmian Canal Commission of 1899-01. This considerably reduces the estimated volume of the excavation, especially for the sea-level projet. Whether the nature of the material will justify so steep a slope in the deep cut is left to be verified in prosecuting the work.

The sea-level projet.—The waterway through the land section is given a depth of 40 feet below mean tide, with a bottom width in earth of 150 feet and side slopes adjusted to the nature of the ground so as to give a surface width varying between 302 and 437 feet. In rock the bottom width is to be 200 feet, and the surface width 208 feet. The least cross section thus slightly exceeds 8,000 square feet. Of the total length of 49.14 miles between deep water in the two oceans, 20.39 miles are to have a bottom width of 150 feet, and 19.47 miles a bottom width of 200 feet.

The curvature throughout is gentle, but for 19 miles a large ship must continuously be changing direction in a channel having a width only from one-quarter to one-fifth of her own length, and which as will appear below may carry currents of about four feet per second. Such a waterway is far from meeting the conception of free and unobstructed passage popularly associated with a sea-level canal.

The total volume to be excavated is estimated at about 231 million cubic yards; and the average cost including all kinds of material at all levels is figured at about 80 cents per cubic yard. It should be stated, however, that this estimate is considerably increased by the Isthmian Canal Commission in transmitting the Report. The total cost of the projet is placed by the signers at 247 million dollars, and by the Commission at 272 millions. The time required to build the canal is estimated by the former at twelve to thirteen years, and by the latter at not less than twenty years.

It remains to consider how the problem of regulating the Chagres River is solved in this projet. During construction numerous temporary diversion channels are recognized as unavoidable, but as many of them will be subject only occasionally to a considerable flow, and as the constant outlay to keep them free from the invasion of the rank tropical growth would be large, most of them are ultimately to be abandoned. The canal itself is to become the channel through which by far the greater part of the volume of the Chagres must reach the sea. The de Lesseps idea of a still water canal is thus replaced by a regulated river, in which a maximum velocity of about four feet per second at times may be tolerated. The means by which this design is to be effected are the following.

The Chagres River where it first strikes the line of the canal near Gamboa carries about two-thirds of its entire volume at Bohio, which in the flood of 1879 was about 112,000 cubic feet per second. This portion, nearly 80,000 cubic feet per second, is to be arrested by an immense dam at Gamboa rising 180 feet above the surface of the canal, distant only about a quarter of a mile. The total length of the crest would be about 6,000 feet, of which 1,000 feet would rise from a level 50 feet below the bed of the river, the excavation being in very permeable sand and gravel. No detailed design for this dam was formulated, and even whether it should be an all masonry structure or a concrete core wall bedded in an embankment formed from the spoil of the Culebra cut was left for future determination. Surveys above the site indicate that the capacity of the lake thus formed would be ample to arrest the largest known flood, and by a system of sluices it is proposed to admit the accumulated volume gradually into the canal at a rate not exceeding 15,000 cubic feet per second. Whether the volume would flow to the Atlantic or through the Culebra cut to the Pacific, or partly by each route, would be determined by the contributions received at the time from the lower tributaries.

The regulation of the tributaries entering the Chagres below Gamboa is not so simple. Those nearest to the Atlantic are the Trinidad and the Gatuncillo. The former is to be confined to the old bed of the Chagres by protection levees bordering the canal for about eight miles above Gatun; the latter, with the other tributaries of the right bank below Bohio, is to be diverted by embankments near Gatun into the unfinished French diversion channel conducting to Manzanillo Bay. Above Bohio the problem becomes more difficult. The volume to be disposed of aggregates about one-third of the total present discharge at Bohio, which in floods may equal 35,000 cubic feet per second—enough to raise the existing river 23 feet at the low stage. The three most important tributaries on the left bank in this district are the Cano, the Gigante, and the Gigantito, all of which enter below Tavernilla. Their contributions are to be held back by four dams, forming two great lakes raised to sufficient heights to admit of drainage near their headwaters, one to Pena Blanca swamp and the other to the Trinidad river, both thus augmenting the volume acting against the canal levees. It is to be noted that time did not admit of detailed surveys for these dams, so that the estimates of cost are based on suppositions. From the best maps available the height above ground of the three largest was assumed to be about 70 or 80 feet, and the aggregate length about 3,500 feet. They were assumed to be of earth.

But these three rivers do not comprise the only important tributaries between Gamboa and Bohio. There are fifteen others which during the nine rainy months are liable at any time to carry considerable volumes, to say nothing of the small drainage channels abounding in a region subjected at this season to a rainfall of over a dozen inches per month. This volume, including the entire contributions from the right bank and all above Tavernilla on the left bank, is to be turned into the canal, causing with that received at Gamboa from the lake, cross currents, possible erosion of banks, and more or less deposition of sedimentary matter to be removed from time to time by dredging. In the Report the maximum velocity of the current in the canal is placed at 2.64 miles per hour, or about 4 feet per second.

Such a route with 19 miles of continuous change of direction, and the difficulties of passing each other superadded, will not be attractive to modern leviathans. The more the problem is studied of how to adjust a sea-level canal to the Chagres River the more difficult does it appear. It is well to recall that since the de Lesseps fiasco the question of the best type of canal has been brought officially before three foreign and one American engineer Commissions, aggregating thirty-nine members, to whom should be added M. Choron, the eminent chief engineer of the New French Company, and that without a dissenting voice the decision has been in favor of the lock type. If the fanciful dream of an unobstructed waterway is to be met the only alternative appears to be to incur the expense of untold milions in opening a " strait " across the Isthmus, and in depriving the present generation of any benefit arising from its construction. The sea-level canal as projected differs widely from such a conception.

But this projet for a sea-level canal does not dispense with a tidal lock. At the Pacific entrance to the canal spring tides have two daily oscillations of about 20 feet, and it was the unanimous judgment of the Board of Consulting Engineers that a tidal lock in duplicate could not prudently be avoided. To admit such tidal waves into a canal already carrying currents was not seriously to be considered. Locks were accordingly projected at a favorable site between Mont Ancon and Mont Sosa, having a serviceable length of 1,000 feet and a serviceable width of 100 feet. It has been claimed that the gates can stand open when the difference between the water level in the canal and in the Bay of Panama does not differ more than a few feet and hence that such locks will be much less of an obstruction to traffic than those of the normal type. Actual experience at the eastern entrance of the Kiel canal does not warrant this claim. There the usual tidal oscillation does not exceed a foot or two, but in wind storms the level may rise about 10 feet or fall about 8 feet in respect to the normal stand, and it was decided that locks could not be avoided. It was however estimated that they would stand open about 330 days in the year. Actual trial has demonstrated the error of this assumption. Even gentle currents have been found to be dangerous to shipping attempting to pass between the lock walls (82 feet apart), and the regulations now require the gates to be kept closed. Evidently, as is contemplated by the projet, a sea-level canal at Panama must be obstructed by a tidal lock at the Pacific entrance; and what may happen at the Atlantic entrance during the rare occasions of the violent tempests known as "northers" is a matter of conjecture. A great tidal wave entering a sea-level canal under such circumstances may work serious damage both to shipping in transit and to the earthen side walls of the canal itself.

The lock canal projet.—The waterway of this type, as projected, has strong points of resemblance to that between Lake Superior and Lake Huron, which now carries more than three times the tonnage passing the Suez Canal, and more than the aggregate passing the four great ship canals of the world—the Suez, the North Sea, the Kiel, and the Manchester. The Poe lock alone in September and October, 1905, when the Board was in session, passed 6,622,239 net registered tons. This great St. Mary's waterway has a total length of about 61 miles. The difference of level between the lakes is about 22 feet, of which 20 feet are concentrated at the Sault Ste Marie. This height is overcome by either one of three locks, which were built in the following order; the Weitzel, having a length of 515 feet and a serviceable width of 60 feet; the Canadian, having a length of 900 feet and a width of 60 feet; and the Poe, having a length of 800 feet and a width of 100 feet. It is proposed to replace the Weitzel lock by a new one having a length of some 1,300 or 1,400 feet and a width of some 75 or 80 feet. The canals proper on both sides of the river are simply approaches to the locks from Lake Superior, the length of each being about 1.5 miles. The rest of the waterway is an improved natural extension of Lake Huron, soon to have channels of a minimum width of 300 feet where used by shipping moving in one direction only, and a width from 600 to 1,500 feet where traversed by shipping moving in both directions. The present depth is nearly 21 feet, soon to be increased to 25 feet.

The lock projet for the Panama Canal contemplates a navigable waterway of this general type, which affords accommodation vastly superior to any that can be constructed in excavation at this locality at any reasonable cost and in any reasonable time. Instead of a relatively narrow channel more or less affected by currents, bank erosion, and sedimentary deposits, unrestricted lake navigation is afforded through a channel never less than 1,000 feet wide for one-third of the entire route. The rest of the distance, except for five miles at the Culebra cut, affords a channel ranging from 800 to 300 feet in width and nowhere subjected even to gentle currents, except for about 4 miles below Obispo in great floods; and even here they will be eliminated when the time comes to build the Alhajuela dam.

Throughout the entire waterway, including the Culebra cut, the normal depth is 45 feet, ranging from 47 to 42 feet according to the stand of the lake, which will never fall below the normal except during the latter part of the three dry months, February, March and April. The Chagres River is simply and effectively controlled, being received with all its tributaries in an immense lake where all currents will be naturally absorbed and where any deposits will be made far from the route for shipping. This liberal increase in sailing width and depth, and freedom from currents and deposits, will offer attractions to mariners far out-balancing the objection of having to pass a few locks.

The size of the locks has been determined by the language of the law authorizing the canal. The largest ships now existing or under construction are the Mauritania and the Lusitania of the Cunard line, which are 800 feet in length, 88 feet in beam, and 38 feet in draft at the maximum load line. A length of 700 feet and beam of 76 feet may be accepted as the dimensions of the largest commercial ships now in use or building that are likely to traverse the canal. The locks are designed to afford a serviceable length of 900 feet and a serviceable width of 95 feet. With a view to absolute security of operation, the projet provides two pairs of gates at the head and two at the foot of each summit-level lock, together with long approach piers and other devices to guard against all possible contingencies; although experience at the St. Mary's Falls canal, where a traffic of 360 million tons net register has passed during the past fifty years without a single accident seriously obstructing navigation, demonstrates how little they are to be feared either for the canal or for the shipping. The chances are as nothing compared with the risks every where encountered from storms on the ocean or in passenger and freight movements by railroad.

The lake forming the summit level, 85 feet above tide, is created by an earthern dam at Gatun, to which unprecedented dimensions have been given in order to place its safety beyond cavil. Its location near the coast, where the valley of the Chagres for a dozen miles rises very gradually above sea level, favors the formation of a deep lake by a dam of moderate height. A water level of 85 feet at Gatun floods an area of about 110 square miles, affording an enormous reserve for canal operation in the dry season; while at Gamboa the dam must raise a lake 130 feet above the bed of the stream to flood about 33 square miles. At Gatun the dam will rest on a formation of rocky impermeable indurated clay, traversed by two ancient gorges now filled by deposits of the tertiary period. In the larger, this deposit consists of a practically impermeable mixture of fine clay and sand extending to a depth of about 200 feet below mean tide, the width at top being about 1,800 feet and at bottom about 900 feet narrowing to about 100 feet. The cross section is about 25,000 feet and the borings show no really permeable material. The smaller gorge is 900 feet wide at top, and is filled with similar material to a depth of about 200 feet below tide. The remaining 60 feet contains a stratum of coarser material which may permit moderate seepage; it has a width at top of about 400 or 500 feet, narrowing to a point at bottom. This dubious material has a cross section of about 15,000 square feet. No imaginable percolation through such material as this is, and at such depth, could endanger the safety of an earthern dam properly planned; and any loss of the low-water reserves can, if deemed advisable, be prevented by the familiar process of pumping down cement grout. Furthermore, if it should be thought expedient to do so, by the use of modern sheet piling and other well-known devices all possibility of sensible seepage can be eliminated. The entire question is simply one of engineering detail to be solved by the chief engineer when the time comes to construct the dam. By far the larger portion rests on ideal foundations.

The only other dams of any importance in the lock canal projet are the three on the Pacific coast to form the small lake at that end of the canal. They are to be of earth, like that at Gatun, and call for no special discussion. Indeed if, as suggested by Mr. Stevens, the tidal lock be placed at Miraflores, as was done in the earlier projets, these dams will not be called for.

The exceptional size of the locks gave special importance to the study of the water supply available during the three dry months; but the ample data collected by the engineers of the French companies, supplemented by measurements made on the Trinidad and the Gatuncillo by the Isthmian Canal Commission of 1899-01, fortunately left no element in doubt. The area of the basin of the Chagres above Bohio is about 700 square miles, and above Gatun about 1,200 square miles. The corresponding lake areas are to be 38.5 square miles and about 110 square miles. The extended series of water measurements conducted at Bohio for fifteen years have made known the volume that the river may be depended on to contribute during the three dry months when the natural flow falls below the requirements of the canal. The absolute minimum volume during this long period was 742 cubic feet per second at Bohio and about 1,225 cubic feet at Gatun.

Allowing 4 feet in depth over the entire lake surface as a reserve, we have an additional volume of 1,577 cubic feet per second available, affording a total of 2,802 cubic feet per second to draw upon. Part of this must be allowed for unavoidable losses from evaporation, infiltration, leakage at gates, power for lighting the canal and operating the locks, etc. Based upon a careful study of all existing data this volume is estimated at 1,437 cubic feet per second. The difference between 2,802 and 1,437—that is to say 1,365 cubic feet per second—represents the volume which can be expended during the three dry months in lockages. The size and lifts of the lock being known, a little calculation indicates a continuous flow of 52 cubic feet per second as that required to supply the prisms for one transit of the canal. Having 1,365 cubic feet available, 26 daily transits are thus provided for, which would accommodate from 30 to 40 million tons of annual traffic, depending on the size of the vessels. When this limit is approaching it will be needful to provide a dam on the upper Chagres for additional reserves. An ideal location exists at Alhajuela, some ten miles above Gamboa, which is vastly preferable to the latter as a dam site. A design was carefully elaborated by the engineers of the French Company, of which the cost was estimated at $2,400,000. With a water surface rising 130 feet above the bed of the river, this masonry dam will collect a reserve during the rainy months sufficient to yield a flow of 2,074 cubic feet per second for the ninety days of the dry season, which will support 40 daily lockages. Obviously there can never be a deficiency of water for any conceivable traffic demands, and by providing additional locks future generations can increase the passage capacity of the transit route to any desired extent.

It remains to consider the dangers which have been urged against the canal, especially one of the lock type. Fanciful speculations have been advanced suggesting attempts to interrupt navigation either maliciously or in time of war. They seem to be wholly uncalled for. We stand pledged to open the route to the commerce of the world, and by adopting the policy of international agreement to its neutrality, so successful at Suez, all danger of its becoming a battlefield will be eliminated. It is conceivable, however, that in the event of a passage of a fleet of battleships in time of war the hostile nation might plot its interruption, and it is therefore pertinent to consider the relative dangers of such attempts directed against a sea-level and a lock canal. The most vulnerable points are not the locks, sluiceways, and dams, for these occupy but little space and can easily be guarded by a small force. The most ready point of attack would be where a narrow waterway traverses a jungle, favoring the placing of a bag of dynamite where the ship must certainly pass, and where its explosion could be effected either by an automatic mechanical device or by a man concealed in the undergrowth, where he would be little exposed to detection by patrols and where he could operate a portable electric igniter. Such places abound on the long and narrow route of the sea-level projet, but are rare and easily watched on the relatively broad lake route. The risk is distinctly greater for the former than for the latter.

Another danger, perhaps unduly magnified at the present time. is that due to a possible earthquake. Fortunately the Panama route traverses a region less exposed to such dangers than any other on the Pacific slope. It lies about midway between the long line of volcanoes extending southward from Colombia and northward from Costa Rica. The latest eruptive rocks of the Isthmus date from the early tertiary period, and what earth tremors are experienced are those transmitted from distant foci of disturbance. That destructive shocks are very rare is attested by the wide flat arch in the old Santo Domingo convent at Panama, which has stood uninjured since the early days of this ancient city. As a measure of the relative danger, it may be noted that seismograph records kept recently for the same forty-four consecutive months at Panama and San Jose de Costa Rica, show four slight shocks lasting ten seconds at the former, and ninety-one slight and thirty-five strong shocks lasting sixteen minutes at the latter. A really formidable earthquake might disturb the adjustments of lock gates, but could hardly effect such an artificial hill as forms the projected dam at Gatun. What it would do to a dam rising nearly 200 feet above its foundations at Gamboa, and sustaining the pressure it may be of a head of 130 feet of water behind it, is not so certain. A failure of this dam from any cause, or indeed of any one of the three high dams on the left bank, would overwhelm a sea-level canal with a flood compared with which the disaster at Johnstown would be as nothing.

It is proper in closing to remark that the details of the projets under consideration were elaborated by a study of only about three months, while those of the two antedating them had received years. For the lock projet, especially, there may be several variants conforming to one general design. Indeed, an examination of these three projets indicates that properly they all may be so considered. For example, the fundamental element which determines the depth of the great cut is the level above tide of the *bottom*, not of the *water* *surface*, of the summit level of the canal. This height was assumed by the French Company at 32 feet, by the Isthmian Canal Commission of 1899-01 at 47 feet, and by the Board of Consulting Engineers at 40 feet. So small differences tend to confirm the belief that the general elements have received the attention requisite to develop wise conclusions, and that actual construction may be actively pressed without fear of radical changes hereafter. Meantime it would be well to consider minor variants, such as that mentioned above suggested by Mr. Stevens.

A brief comparison of the last and the earlier projets may be suggestive. One of its undoubted merits is the extension of the lake to cover the valley below Bohio. This eliminates two objections to the Commission projet—lifts of 45 feet at Bohio, and the excessive volume discharged upon the district below where the canal was to be at sea-level. It improves the French projet by doing away with the extensive use of regulated spillways and of the necessity of two lakes to control the floods—thus largely increasing the capacity of lake Alhajuela for low-water reserves. Incidentally it renders of no importance the fact that the lock site at Bohio is too short to accommodate two locks in flight having the dimensions called for by Congress.

In view of the vigorous attacks that have been made upon the dam and three locks in flight at Gatun, attention may be invited to the fact that small changes are here possible. By transferring the upper lock to Bohio the flight at Gatun will be reduced to two locks, and the height and dimensions of the dam will be greatly reduced. At the Bohio site there is ample space for a single lock, and a dam there raising the lake above to 85 feet will retain all the advantages of the Board projet from that point to the Pacific. The lift will be only about 25 feet, and the counter pressure of the lake below will render seepage under the dam of no importance. Indeed it may easily be eliminated if so desired by familiar methods. The only objection to this modification will be a reduction of storage space for the low-water supply, but computations demonstrate that this may be met practically by an earlier construction of the Alhajuela dam. Another possible variant, which would however involve an increased cost of construction, would be to reduce the summit level to about 65 feet, with one lock at Gatun and another at Bohio, the descent being made by three locks as in the projet of the French Company. This would still retain the advantages of the lake below Bohio, raised to a height of about 33 feet only. In a word, the lock solution admits of several variants by which any criticisms raised against the Board projet may be readily met if desired.

EARLIER AND MODERN WET-GRINDING MACHINES AND PRACTICE.

By H. F. Noyes.

THE ENGINEERING MAGAZINE was early to recognize the importance of the grinding machine, and the part it was to play in the profitable specialization of metal cutting. It is not the supplanter, but the most useful coadjutor, of the older forms of machine tool. Two years ago we presented a very interesting article on the subject, by Mr. C. H. Norton, dealing principally with the character of the work turned out and the action of the cutting wheel. Mr. Noyes takes the matter up from the point of view of mechanical development and working practice. —THE EDITORS.

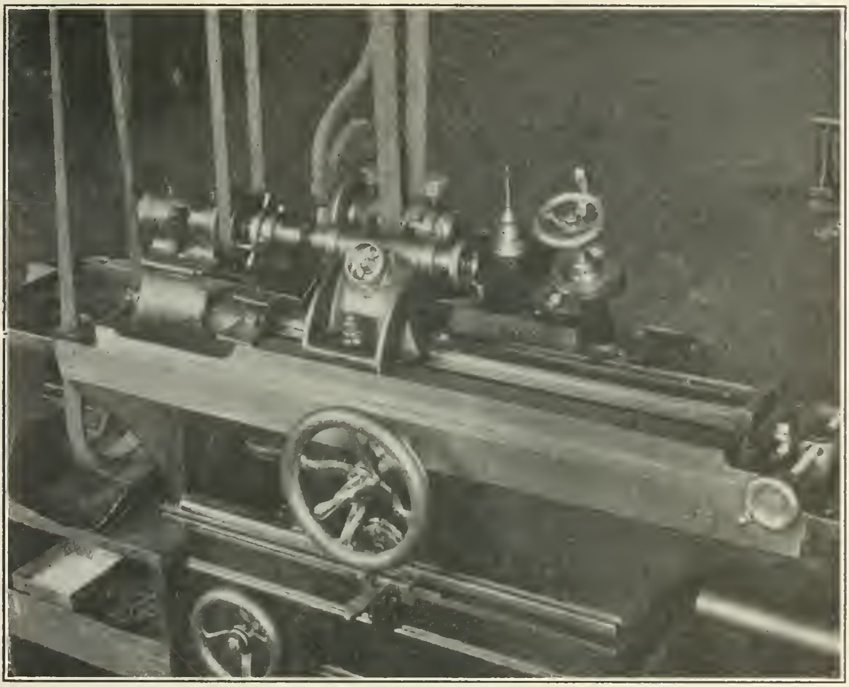
THE practice of commercial wet grinding has changed so materially within the past few years, both in the design of machines and, incidentally, in the quantity and quality of work turned out, that what was considered good performance five or six years ago is wholly obsolete now.

The grinding machine is a finishing machine, its business being to finish, to whatever limits are desired, work which has been previously turned to within about 1/32 of an inch of the desired size. The limits vary according to the requirements and size of the work from one-eighth of .001 inch in small and delicate work to .001 inch or .002 inch on large work such as engine parts; therefore the grinding machine must be the most accurate of all our machine tools.

The purchasing agent of today, who is looking for a wet cylindrical-grinding machine, is practically confined to three makes, The Norton Grinding Co., Worcester, Mass.; The Landis Tool Co., Waynesboro, Pa.; and The Brown & Sharpe Mfg. Co., Providence, R. I.

Of these firms, the Brown & Sharpe Mfg. Co. is the oldest and as early as 1876 had machines on the market. The original inventor of the universal grinding machine was Mr. S. R. Brown, one of the founders of the Brown & Sharpe Co., and one of his patents issued in 1877 shows most of the elemental features found in the machines of today. The use of a swivel headstock on a swivel table was one of his inventions, and his patent controlled the use of this device until its expiration.

The earlier machines of this class were designed by Mr. E. H. Parks, for many years an engineer with this company, and the



THE FIRST LANDIS GRINDING MACHINE. 1886.

later ones by Mr. C. H. Norton, now of the Norton Grinding Co., who designed the first Brown & Sharpe plain machines.

The second to enter the field of grinding machinery was the Landis Tool Co., at that time as Landis Bros., with machines which were the inventions and design of Mr. A. B. Landis. His first machine, which is here illustrated, was built in 1886 at the shops of the Geiser Co., Waynesboro, Pa., where he was then employed; and this machine is today running at their plant. It is a matter of interest that it practically had its inception through the refusal of the superintendent to get for Mr. Landis a Brown & Sharpe machine which he wanted for the tool room.

The distinctive characteristic of this machine, which has been carried through all the machines of Mr Landis' design, is the idea of traversing the grinding wheel longitudinally of the work, in distinction from traversing the work.

The third to enter the field was the Norton Grinding Machine Co., with machines from the designs of Mr. C. H. Norton, also of the Norton Emery Wheel Co., who had previously been identified with this line of work with the Brown & Sharpe Co.: and while this is the youngest company of the three, their machines show some of the most advanced practice and Mr. Norton has long been recognized as a pioneer in grinding-wheel manufacture and practice.

In tracing the development of these machines, which has taken place along much the same lines as other machine tools, no radical changes appear. It has been a step-by-step process, each step in the direction of getting out a little more or a little better work in the same time.

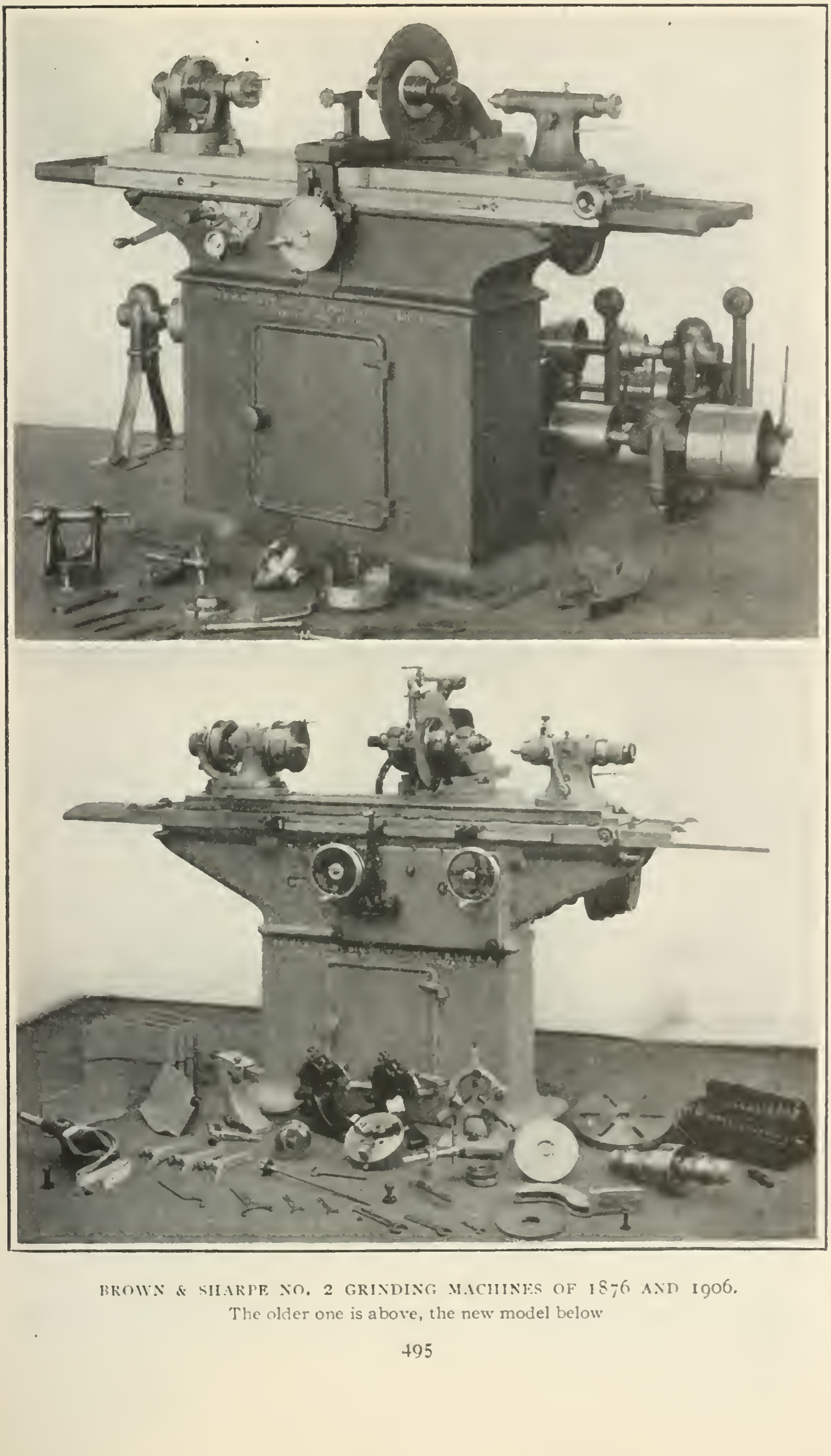
In this development, the greatest obstacle to be overcome has been to obtain finished work—that is, work free from chatter—and to obtain it in reasonable time. The earlier successful machines, which were all of a capacity approximating 12 inches by 48 inches, used grinding wheels of about ½-inch face, run at a surface speed of about 6,000 to 8,000 feet, work speeds of about 200 feet, and a traverse of about 1/16 of an inch or less per revolution of work. There are records of very much faster work speeds and slower traverse per revolution, but these were the first commercially successful speeds for general work. These wheels were at first made narrower at the cutting edge, sometimes as narrow at ⅛-inch, and for a long time this was the general practice.

The first attempts to increase the output, were by using the full width of a ½-inch-face wheel and greater traverse per revolution. This increase was met with chatter marks.

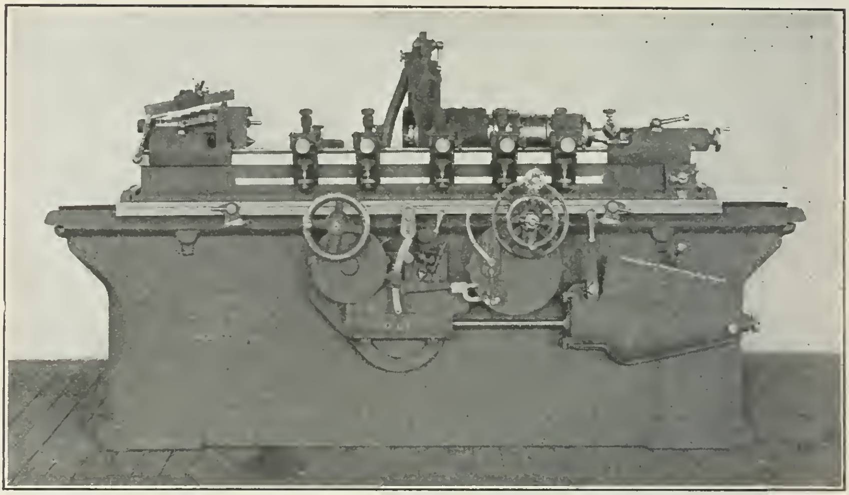
Various attempts to remedy this were made with different grades and grains of wheel, sometimes successful and sometimes not; then the grinding machines were made heavier. This was one of the most essential steps in the right direction, but not until the work speeds were reduced was really satisfactory progress made. With this knowledge came a gradual change in the general practice. Wheels were increased in face from ½ to even 1½ inches for smaller machines; traverse per revolution was increased in proportion. A further increase was made in the weight of the machines. Then the advantage of the back rest began to be appreciated, and from supplying one back rest to a machine, which was the earliest practice, the number of rests has increased until today it is usual to supply one for every 12-inches length of work, or even less.

At the same time the water supply was increased from a scanty stream just about enough to keep the wheel wet, to the full area of a ¾-inch or 1-inch pipe.

The net result of these changes has been to transform the grinder from a delicate machine suitable only for a little tool-room



BROWN & SHARPE NO. 2 GRINDING MACHINES OF 1876 AND 1906.
The older one is above, the new model below



BELT DRIVEN 10 BY 50 INCH GRINDING MACHINE.
Norton Grinding Co., Worcester, Mass.

work, such as grinding tools and hardened steel for various purposes, to a solid, powerful machine tool, almost capable of competing with the lathe in the reduction of work, and wholly distancing it in the matter of sizing and finishing work.

The accompanying illustrations also show the general improvement in design and appearance of the machines; and one striking feature which they bring out is the great increase in the number and variety of fixtures with which these machines are supplied.

The Brown & Sharpe No. 2 machine of 1876 was practically the first wet-grinding machine on the market. A comparison between it and their No. 2 machine of today shows many marked changes along these lines. The most significant are wider emery wheels, a decided increase in the water supply, a much more suitable and handy arrangement for controlling it, a great increase in the number of back rests and attachments, and in weight.

One feature which has been greatly developed on the Brown & Sharpe machines is the automatic feed. This is so designed that it automatically effects a movement of the emery-wheel base, equivalent to a work reduction of one-quarter of .001 inch or more, either at each reversal of the table, or at one end of the work only; and it can be arranged so that the wheel will dwell for a certain number of revolutions of the work at each reversal of the table.

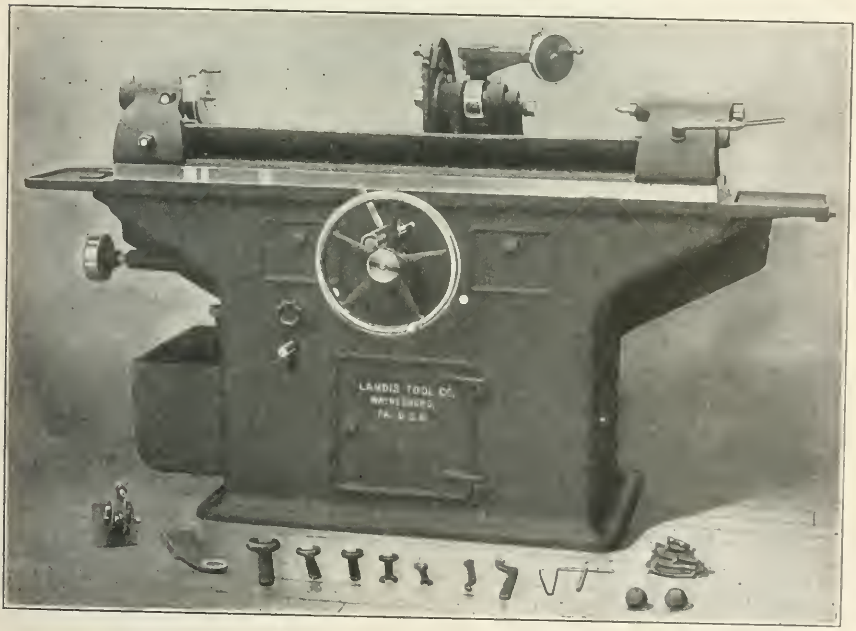
The first grinding machine built by Mr. Landis weighed about 3,000 pounds, while their present No. 1½, which compares with it in capacity, weighs about 4,800 pounds.

The Landis No. 3 machine, illustrated, of 1892, weighed about 3,800 pounds, and used a wheel 12 inches in diameter by ½-inch face. The present type No. 3 machine weighs 5,800 pounds and uses a wheel 1-inch to 1½-inches face.

The two Norton machines illustrated, their 10 inch by 50 inch belt-driven, and 18 inch by 168 inch motor-driven, are their latest type of machines, the latter being one of the largest machines on the market. One of the distinctive features of these machines is their handiness in the matter of speed control, both the work and traverse speed variation being obtained by the manipulation of levers.

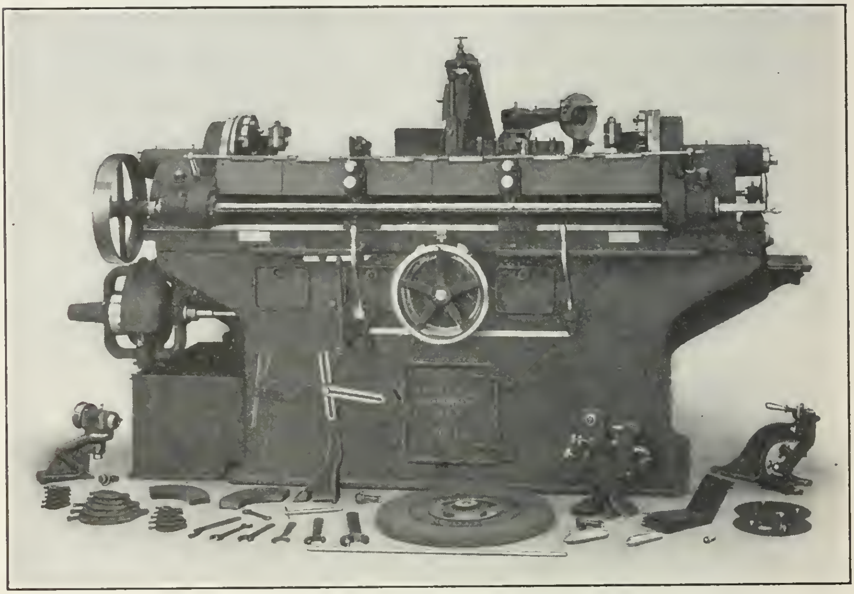
The Landis Tool Co. have also brought out some large machines, having regularly on the market a machine with a capacity of 30 inches by 150 inches, weighing 40,000 pounds and taking a wheel 30 inches in diameter by 3-inch face. They have also recently built a machine of 20-inch swing taking 200 inches between centers. This company have developed a crank-shaft grinding machine using a 24-inch diameter emery wheel and having heads with fixtures adapted to carry two, three, four, or six-throw cranks, and having an indexing device whereby for any of these throws the wrist pins may be quickly aligned with the work centers for grinding.

Co-incidentally with the development of machines, the face,



LANDIS TOOL COMPANY'S "PLAIN GRINDER NO. 3" OF 1892.

grade, and grain of grinding wheels used has undergone considerable change. Wheels are now wider, coarser, and softer than formerly, and are less frequently changed for a change of material, a variation in work speeds being often all that is necessary.

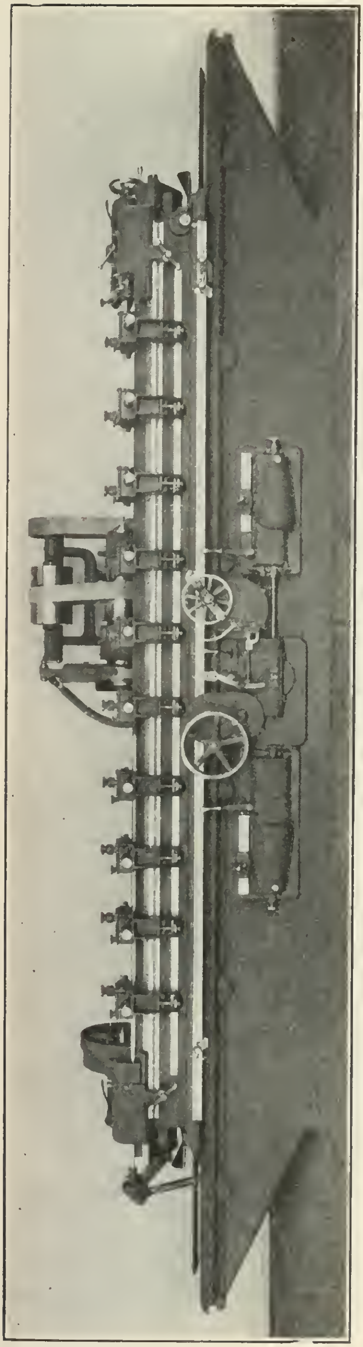


LANDIS CRANK SHAFT-GRINDING MACHINE.

The general practice of these three companies in regard to wheels and speeds is now much alike, except in work speeds; but in the latter point there is a great variation between that of Brown & Sharpe and the other two.

The following table shows in a comparative way these differences:—

Name of makers.	Grinding wheel surface speeds ft. per min.	Work surface speeds ft per min.	Traverse per revolution of work unit—width of wheel face	
			Roughing	Finishing
Brown & Sharpe	6000—8000	75—100	$\frac{1}{2}$—$\frac{2}{3}$	$\frac{1}{8}$—$\frac{1}{3}$
Landis Tool Co.	5000—6000	10—40	$\frac{2}{3}$—$\frac{3}{4}$	$\frac{1}{3}$ or less according to finish
Norton Grinding Co.	5500—6000	6—40	1	less according to finish



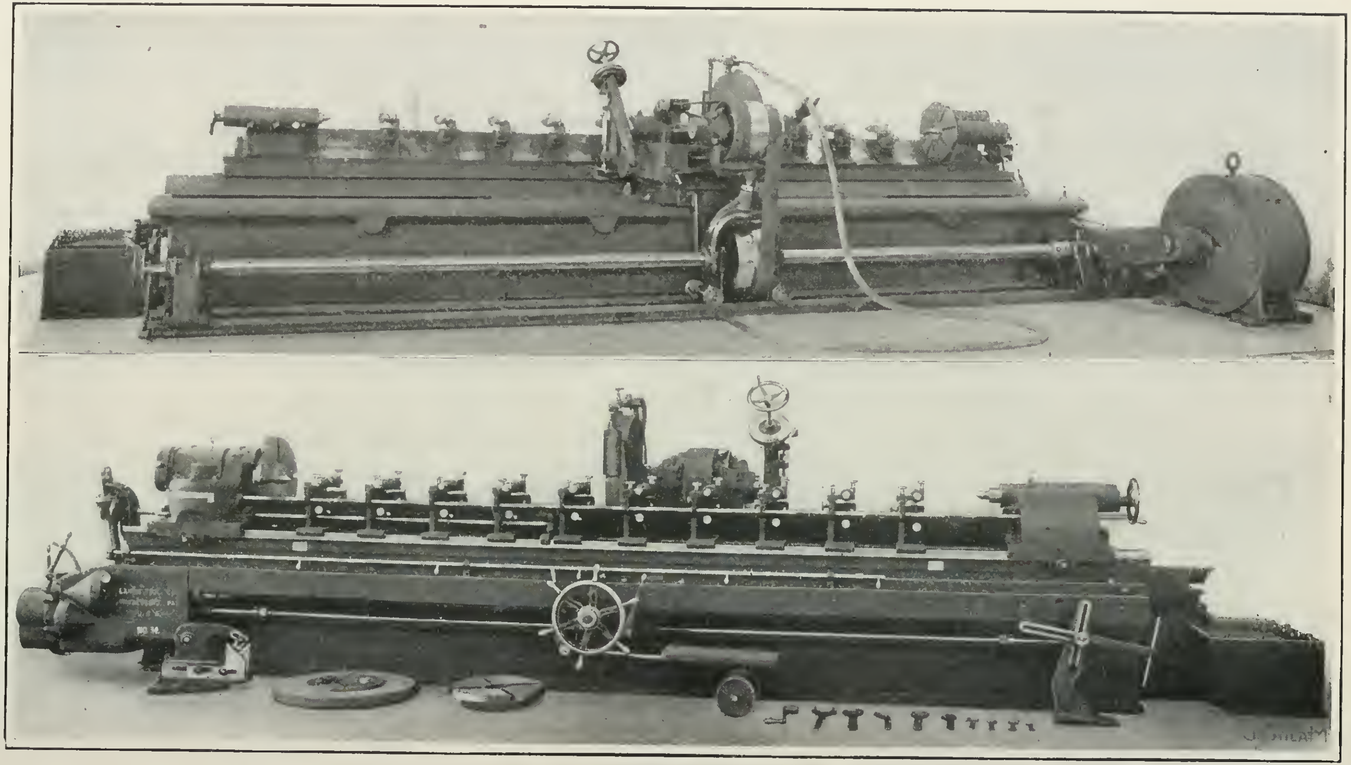
NORTON GRINDING COMPANY'S 18 BY 168-INCH MOTOR-DRIVEN GRINDING MACHINE.

For grinding wheels all recommend about the same grade and grain of wheel.

Brown & Sharpe use carborundum 70 grade K, corundum 46 grade 2½, and emery 36 grade 4, for soft steel, cast iron, and bronze, recommending a slightly finer wheel for hardened steel. Landis Tool Co. use for practically everything wheels varying from 24 to 60, and of a medium grade to about two grades softer. Norton Grinding Co. use mostly 24 combination wheel, grade L, occasionally grade M.

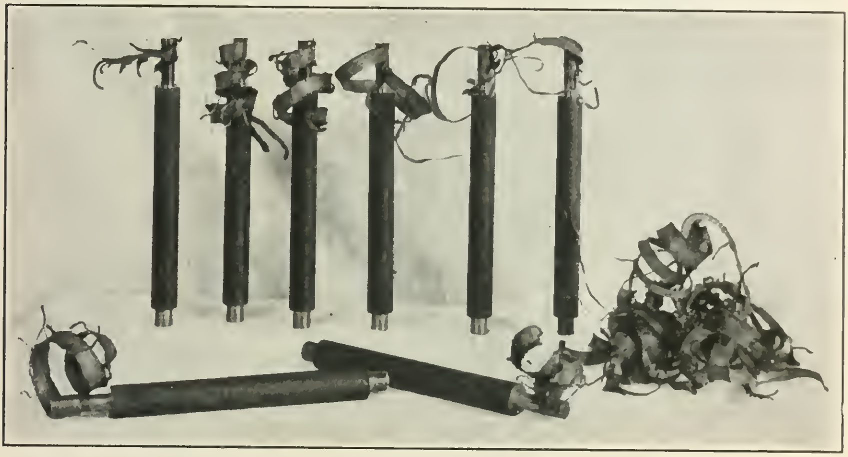
It will be seen that the Norton Grinding Co and the Landis Tool Co. have gone very much further than the Brown & Sharpe Co. in the reduction of work speeds and increase of traverse per revolution. The two former also believe in a much wider-faced wheel for the same capacity of machine. For instance, the Brown & Sharpe No. 14 machine of 10 inches by 48 inches uses a 1½-inch-face wheel, while the Landis No. 23, 12 inches by 42 inches, uses a 2½-inch wheel, and the Norton 10 inch by 50 inch machine uses a 2-inch-face wheel.

How far this development will continue along these lines is problematical. It may be that the limit has about been reached. On the other hand, it is possible that a very wide wheel, say 6-inches face, with work supported by back rests very close together, would remove stock as much faster than a 3-inch wheel,



"SEMI-UNIVERSAL" LANDIS GRINDING MACHINE, 20 BY 174 INCHES. FRONT AND REAR VIEWS.

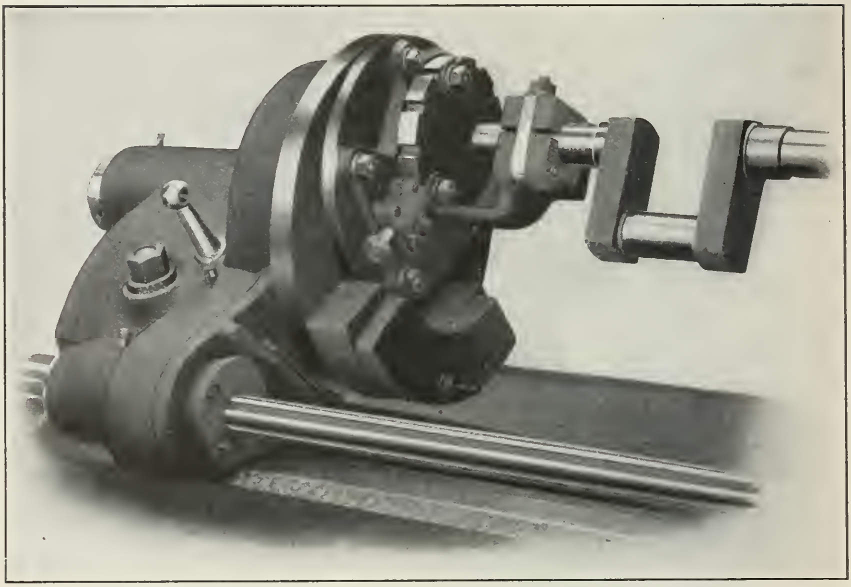
as the latter does than a 1½-inch. But granting that this would be the case, and that it could be done with freedom from chatter, the additional power required would probably cost more than the saving in time, for the large wheels require lots of power behind them.



SPINDLES WITH CHIPS FROM THE GRINDING MACHINE.

Formerly it was considered impossible to grind any thing but straight cylindrical, tapered, or flat surfaces, owing to the fact that it was thought necessary that the wheel or work have longitudinal traverse, one with respect to the other. Recently, however, much work has been done, when shape permits, by simply sinking straight in with the wheel, for its full width, without any traverse. As an example of this work are shown some spindles ground in the Landis Tool Company's works, where a short neck of comparatively small diameter was to be put on the end of a spindle. This neck was ground down from the rough, and reduced in diameter from 1 3/16 inch to 15/32-inch, using a 1½-inch-face wheel. In roughing out these ends, taking a heavy cut, the cuttings from the metal became fused together and curled up in chips much in the same manner as if a cut were taken with a wide lathe tool, and the photograph shows these ends with the chips still hanging to them. During this operation, stock was removed at the rate of 1¾ inches per minute.

In much the same manner it has been found practicable to finish pulleys, both single stepped and cone pulleys, and put on the crown, with a wheel of face as wide as the pulley. The surface of the wheel is first given a concave face by means of a diamond truing



FIXTURE FOR ALIGNING CRANK, FOR FINISHING BY GRINDING.

device working on a long radius, the arrangement being such that the actual radius may be made greater or less according as the face to be ground is wider or narrower.

The work is roughed out on the lathe, leaving a straight face, and all the crowning done with the emery wheel.

It has been found practical to finish cone pulleys having six steps from 10¼ inches to 4½ inches in diameter with 1½-inch faces in this way at the rate of ten per hour.

Another new form of work, ground, originating partly through the demands of the automobile industry, is a large radius on fillets such as on the wrists of crank-shafts. For this purpose a radial diamond tool has been brought out which will put a convex radius on each edge of the wheel, any radius being obtainable up to ¾ inches. In this case, owing to the varying length of the crank wrists, usually a slight traverse of the work or wheel, one with relation to the other, is required.

NOTE.—The author is indebted to C. H. Norton, the Browne & Sharpe Mfg. Co., and the Landis Tool Co., for much of the material of this article.

HIGH-LIFT TURBINE PUMPS. THEIR DESIGN AND EFFICIENCY.

By R. J. Durley.

It has long been known that the ordinary centrifugal pump is not an efficient machine when operated against high heads, and it is only within a comparatively recent date that its scope has been extended by the simple plan of arranging several pumps in series, each delivering to the next, a cumulative pressure thus being attained without excessive rotative speed, much in the same manner as an increase in electrical voltage is secured by connecting a number of battery cells in series. Another simple process seems to have taken a long time for its practical inception, the application of the principle of reversibility, rendering all the fund of experience in the improvement of the hydraulic turbine available for the machine in which work is put instead of being taken out, while the water flows up instead of down. Professor Durley gives a clear review of the work which has been done in this important department of engineering during the past few years, showing that it means an extension of the field of the hydraulic engineer, without encroaching upon the domain of the reciprocating pump.—THE EDITORS.

GOOD mechanical engineering requires the attainment of the desired end by the use of the simplest, most economical, most durable, and most reliable means. Progress in the solution of mechanical and electrical problems involves methods of simplification more frequently than of complication, and this tendency is well exemplified in the changes that have recently taken place in the design of machinery used for pumping against high heads. Until quite lately a reciprocating pump was a necessity for dealing economically with pressures exceeding about 60 feet of water, and the difficulties experienced in driving large pumps of this kind by electric motors seriously limited the use of electric driving for pumping purposes. Heavy and expensive gearing, with its accompanying noise, vibration, and liability to break down, was a necessity in most cases. The only kind of reciprocating pump available for direct driving by slow-speed motors was the so-called "Express" type, fitted with mechanically operated valves, and the use of these pumps was also open to the objections of complication and high cost of installation and maintenance, although they achieved remarkable results at high speeds and lifts as compared with the older geared forms.

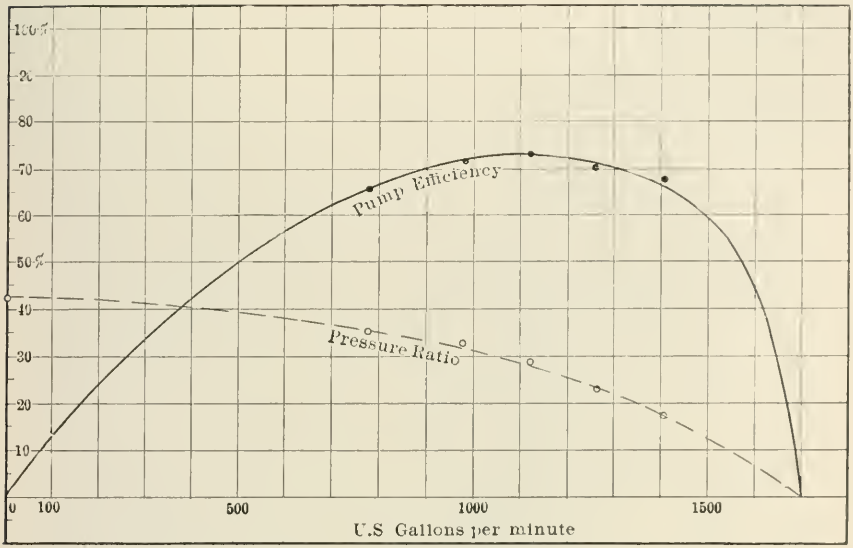
The centrifugal pump, in which there is only one moving part, the runner or impeller, is, of course, the simplest form of pump from a mechanical point of view. Unfortunately the commercial use of such pumps has hitherto only been possible under certain conditions, and for low heads, but a machine of the same simple mechanical construction and having only one moving part is now available for high heads, in the shape of the high-lift turbine pump.

The name high-lift centrifugal pump is, however, equally applicable, for such pumps are essentially centrifugal pumps in which a ring of guide blades surrounds the impeller. They are, therefore, practically reversed inward-flow (Francis) turbines, but of course differ from such turbines in the shape and curvature of their wheel vanes and guide blades.

It is well known that the ordinary centrifugal pump has a low efficiency when working against high heads. This is due to the fact that with high speeds in pumps of this kind the frictional and eddy losses bear a very high proportion to the amount of useful work actually expended in pumping the water. A typical centrifugal pump of ordinary design, showing a maximum efficiency of say 70 per cent at 20-feet lift, will show only about 20 per cent at 80 feet. Efforts to utilize such centrifugal pumps for higher lifts by running two or more in series have not achieved commercial success.

The water streaming from the rim of the impeller of a centrifugal pump possesses kinetic energy, derived directly from the work expended in rotating the pump shaft. If the vanes of the impeller were radial in an ideal frictionless centrifugal pump, and if the whole of the kinetic energy of the water at the rim of the impeller could be transformed into pressure energy, then the pressure (measured in feet of water) against which such a pump could just deliver, would be calculated by the expression $v^2 \div 32.2$, where v is the linear velocity of the rim of the impeller in feet per second.

If we take the case of water delivered from an ordinary centrifugal pump with a velocity of 10 feet per second in the discharge pipe, and under 50-feet head, the total energy possessed by each pound of water delivered is 51.55 foot-pounds, of which 1.55 foot-pounds is kinetic energy and 50 foot-pounds is pressure energy. An ideally perfect pump would, of course, attain this result by the expenditure of only 51.55 foot-pounds of work per pound of water pumped, and the impeller would have a peripheral velocity of about 41 feet per second An actual pump, however, working under these conditions, and having an efficiency of perhaps 50 per cent would evidently require the expenditure of twice as much work per pound of water pumped, and, further, the impeller would have to be driven at a considerably higher speed, depending on the design of the pump, but probably about 60 feet per second. To judge of the performance of a centrifugal pump, under



The Engineering Magazine

FIG. 1. TESTS OF 8-INCH CENTRIFUGAL PUMP.

At constant speed of 2,000 revolutions, 45 ft. lift; diameter of impeller 8.3 inches; De Laval Co.

any given conditions, it is thus necessary to know two quantities; (a) the efficiency, or ratio of the useful work done to the work expended in driving the pump; and (b) the "manometric coefficient," or pressure coefficient, which is the ratio of the actual pressure in the pump discharge to the pressure which would be attained in an ideally perfect pump with the same peripheral velocity of impeller. Curves of these two quantities, plotted with regard to the amount of water discharged will give all necessary information as to the performance of a pump at a given speed throughout its whole range, from the point at which the discharge is zero and the pressure large, to the point at which the pressure is zero and the discharge a maximum. The forms of these curves are affected very considerably by the shape of the vanes of the impeller, and can be varied by a skilful designer to suit the special conditions under which the pump is to work. Figure 1 shows the efficiency and pressure curves as drawn for an 8-inch low-lift centrifugal pump tested by Messrs. Denton and Kent. The pump was designed for a delivery of 1,200 U. S. gallons per minute against 45 feet head when running at 2,000 revolutions per minute, and it will be seen that while the maximum efficiency of the pump occurs at very nearly the designed rate of discharge, it falls off very rapidly when delivering larger quantities of water. The curves of Figure 1 correspond to the forms usually shown by pumps in which the vanes are curved backwards at the tip, and such impellers may be used in cases where a pump has to work with fair efficiency at constant speed while the head is varied over a considerable range. It is possible by modifying the shape of the vanes and making them more nearly radial, to obtain a pressure-coefficient curve which is approximately horizontal for a considerable variation of the amount of water pumped, indicating that with such an impeller when the demand for water is changed the pressure will remain nearly constant while the pump runs at constant speed. Such a design is evidently suitable for a pump supplying a boiler-feed system, a service which is now well within the capacity of a high-lift centrifugal pump. By still further changes in the design of the vanes, we are even able to obtain a pump in which the head increases as the delivery is increased. In an electrically driven pump, where there is danger of overloading and burning out the motor by opening the discharge valve and increasing the amount of water delivered by the pump, backward-curved vanes should be used, and in most cases the pump should be so designed as to cause the pressure-coefficient curve to drop sharply at a point just beyond the intended maximum delivery.

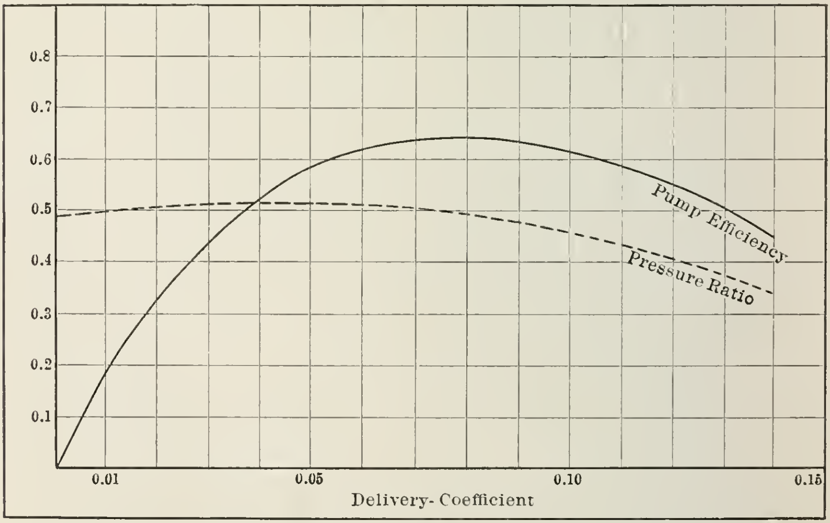


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FIG. 2. RATEAU MULTIPLE-STAGE PUMP FOR HUANCHACA CO., BOLIVIA.
1,450 revolutions, 590 ft. head, 925 imperial gallons per minute.

Such curves as those just given may be called the characteristic curves of the pump, although they apply only to the particular pump and speed for which they are drawn. In has been pointed out by M. Rateau that instead of measuring quantity of water along the base line of such curves, a quantity called by him the "delivery-coefficient" *"coefficient de débit"* or *"pouvoir débitant"* may be used with advantage. This delivery-coefficient is numerically equal to the amount of water discharged, divided by the peripheral velocity of the impeller, and by the square of the radius of the impeller. A given characteristic curve plotted in this way then becomes applicable to all sizes of pumps of the same design, providing that for each size the correct speed is used. This result follows from the fact that the quantity delivered by an ideal centrifugal pump would vary as the peripheral velocity of the impeller, and also as the square of the linear dimensions of the pump. Figure 2 gives such a characteristic curve for a four-stage high-lift turbine pump; the general similarity of the curves to those of Figure 1 will be evident.

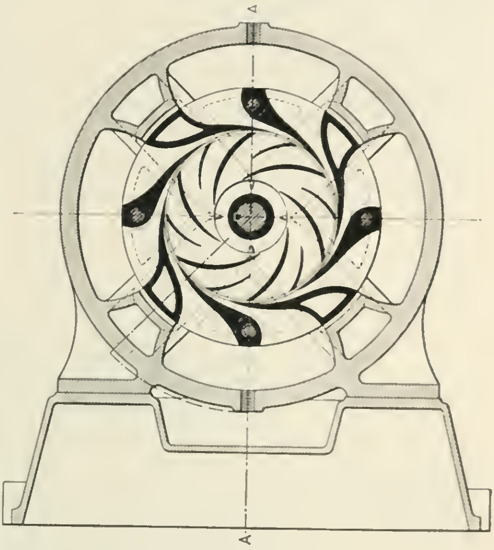

FIG. 3. CROSS SECTION THROUGH HIGH-LIFT TURBINE PUMP, SHOWING ARRANGEMENT OF IMPELLER, DIFFUSION RING, AND GUIDE BLADES.

Buffalo Steam Pump Co., Buffalo, N. Y. See also longitudinal section page 511.

As has already been stated, the improvement which differentiates the high-lift centrifugal or turbine pump from the ordinary low-lift centrifugal pump, consists in the addition, outside of the impeller, of a " diffusion-ring " containing stationary guide blades (Figure 3). By means of these guide blades the water leaving the impeller is smoothly conveyed to the annular discharge chamber surrounding the guide ring, and its velocity head is thus more effectually converted into pressure head. In other words, the rapidly moving water leaving the impeller is led into the pump-discharge space with less loss of energy from shock or eddies than would otherwise be possible. The high peripheral velocities of impeller necessary for high heads can then be employed without a corresponding diminution of efficiency. The practical result obtained by this method of construction is that pumps having a single impeller can deal with heads exceeding 100 feet with good economy; the efficiency possible depends on the design of the pump, and especially on the relation between the diameter of impeller, the required number of revolutions, and the amount of water to be pumped. By placing turbine pumps in series, so that the first impeller discharges into a space connected to the suction of the second wheel, and so on, a multiple-stage pump is obtained, and it is evidently possible to pump against correspondingly greater heads; under these conditions a pump efficiency of over 70 per cent is frequently attained. The greatest head dealt with commercially up to the present time appears to be about 1,500 feet, but for such a lift the usual practice would be to use two or more multiple-stage pumps in series. The usual head for a single multiple-stage pump is from 300 to 600 feet.

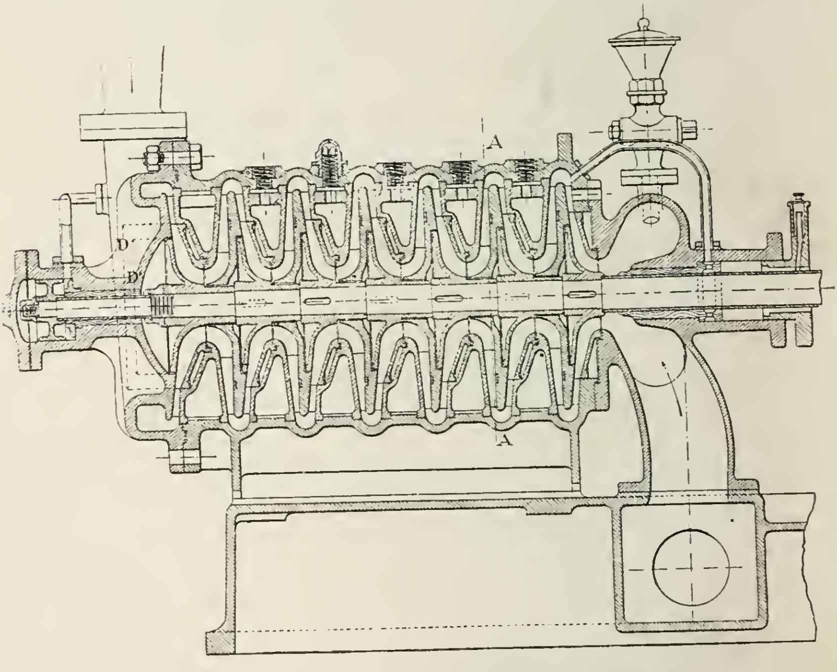

FIG. 4. LONGITUDINAL SECTION THROUGH SEVEN-STAGE RATEAU HIGH-LIFT CENTRIFUGAL PUMP.

MM. Sautter-Harlé, Paris.

It must not be supposed, however, that such results as those just stated have been attained without much trouble, and without overcoming many practical difficulties. One of the first of these difficulties to make itself felt was that arising from end thrust on the pump shaft. In a single-stage turbine pump, as in an ordinary centrifugal pump, the water at entrance to the impeller is flowing parallel to the axis of the shaft, and in being deflected so as to move in a radial direction it exerts a considerable thrust along the shaft. The simplest

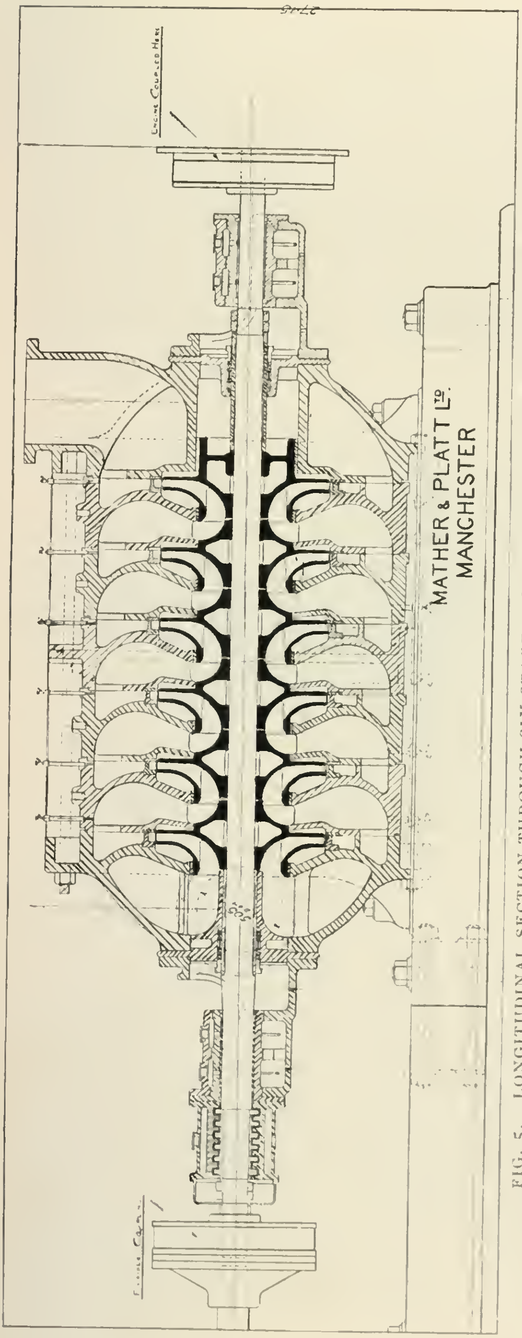

FIG. 5. LONGITUDINAL SECTION THROUGH SIX-STAGE HIGH-LIFT PUMP, SHOWING BALANCING DISC.
Designed for 4,500 imperial gallons per minute against 300 ft. head at 335 revolutions. Mather & Platt., Ltd., Manchester.

method of avoiding this is to use an impeller taking water from both sides, as in the case of the ordinary double-suction pump. But when a number of impellers are placed in series on the same shaft, as in the case of the seven-stage pump of Figure 4, this arrangement becomes somewhat difficult to carry out, and in the pump illustrated the impellers take water on one side only. The end thrust is then taken care of by suitably proportioning the areas of the two sides of each impeller, and by the use of a rotating balance piston, one side of which is exposed to the pressure in the discharge pipe. It will be noticed that in this pump the impellers have a larger diameter on the inlet side than on the side nearest to the pump discharge; these areas are chosen so that the difference of the total pressures on the two sides of each impeller balances its own end thrust as nearly as possible. In the design of Figure 5 single impellers are also used, but in this case pressure is admitted to the face of a rotating disc of proportionately larger diameter, and collars on the shaft are provided to take up any thrust that may occur when the pump is running at variable load. With this arrangement there is of course a certain amount of leakage from the discharge into the suction of the first impeller, but the amount of water lost in this way is very small, and the adjustment of a valve in the balancing pipe renders it possible to vary the pressure on the balancing disc so as to allow for any change in the amount of end thrust to be balanced, resulting from an alteration in the amount of water delivered or in the head overcome.

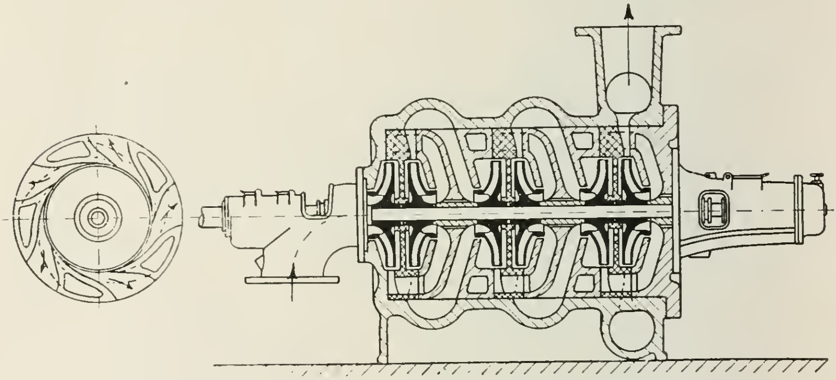

FIG. 6. LONGITUDINAL SECTION THROUGH SIX-STAGE PUMP.
Gebrüder Sulzer, Winterthur.

One of the first multiple-stage pumps adopted an arrangement in which the impellers were placed in pairs back to back (Figure 6), and this system is still followed by several builders. In the Buffalo pump Figure 7 we have a somewhat similar design, in which the spaces between the outer faces of the impellers and the adjoining casings are used as pressure chambers, each being filled with water at the delivery pressure of its own impeller. Packing rings are fitted, so as to prevent leakage from the delivery to the suction side, and the areas of the two pressure chambers of each impeller are arranged so as to make the total difference in axial pressure approximately equal to the thrust due to the difference of inlet opening in the two impellers of the pair. In this way each pair of impellers is balanced separately. Evidently in a pump of this kind an even number of stages must be employed.

The pump of Figure 8 also utilizes the opposing thrust of the various impellers so as to produce a balanced shaft, but in this case single impellers are used, an equal number facing each way. The arrangement is an ingenious one, and does away with the necessity of making ports in the division plates between the stages (as is done in the pumps of Figures 6 and 7), in order to provide openings through which the water can pass from the guide blades of one stage to the suction of the next. In Figure 8 these connecting passages are all formed in the outer casing of the pump, and while not so short and abrupt as in the pumps of Figures 6 and 7, afford a considerable area of wetted surface exposed to the friction of the water. It will be seen that the pump of Figure 8 is also provided with pressure chambers, and has no thrust bearing or rotating piston.

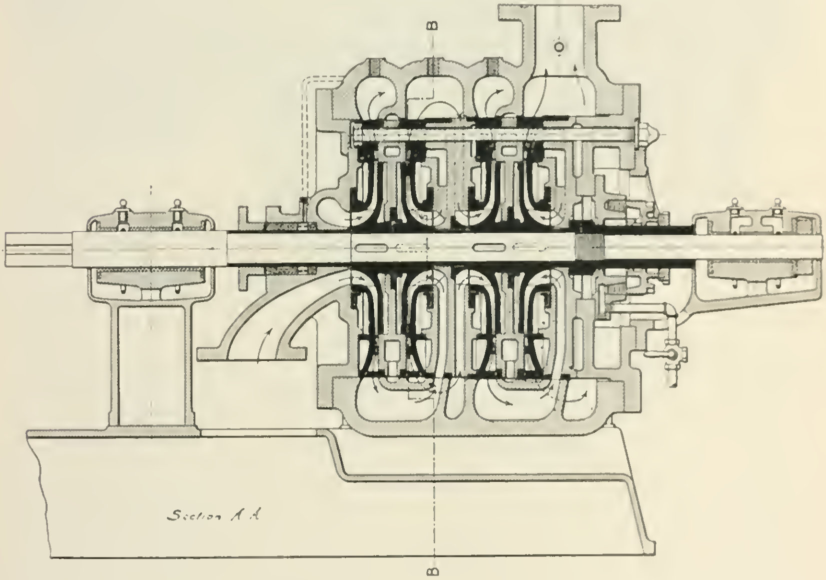

FIG. 7. LONGITUDINAL SECTION THROUGH FOUR-STAGE PUMP.
Buffalo Steam Pump Co., Buffalo, N. Y. Compare with cross section on page 507.

Another method which can be employed to balance a single-suction impeller involves the use of radial vanes formed on the outside surfaces of the impeller, and therefore rotating the water in the pressure chambers. By proportioning correctly the length and clearance of these vanes, the pressures existing in the various pressure chambers while the pump is running can be brought to the amounts required for balance. These so-called "triple vanes" no doubt increase slightly the power required for driving the impeller, but it is questionable

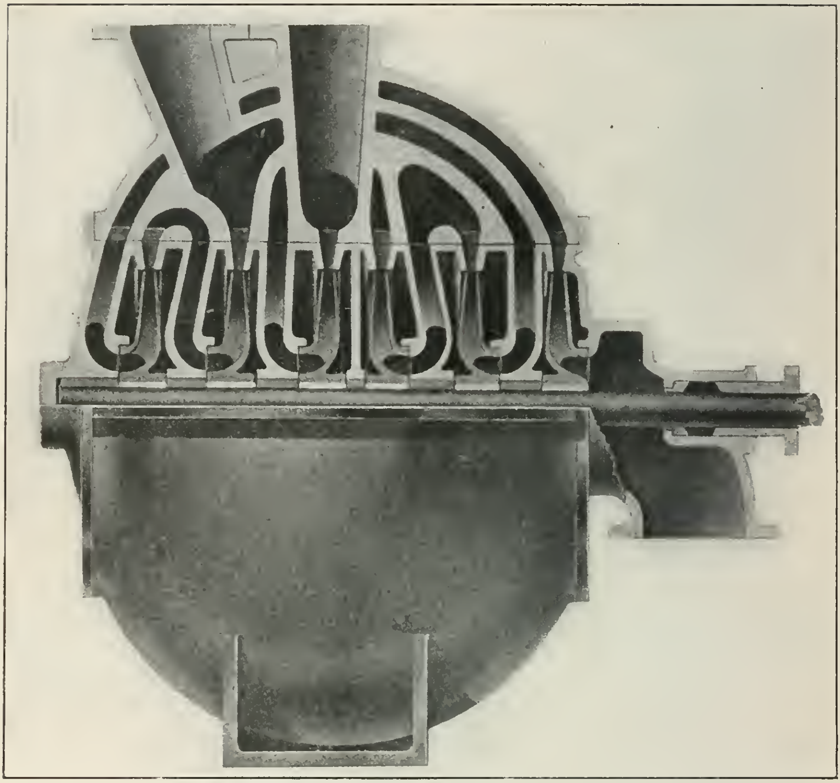

FIG. 8. LONGITUDINAL SECTION THROUGH SIX-STAGE PUMP.

Lawrence Machine Co., Lawrence, Mass.

whether the power wasted in the thrust bearing of an imperfectly balanced pump would not be greater than any loss due to the triple vanes.

The system of making holes in the sides of the impeller, adopted also in certain water turbines of the Francis type, has been used by some builders of high-lift turbine pumps. The object of such holes is, of course, to obtain the required pressure on the outer surfaces of the impeller by admitting water from the inside passages to the pressure chambers.

The construction of the main bearings and stuffing boxes in a high-lift turbine pump has to be carefully considered. It is good practice to arrange the design so that the bearings and stuffing boxes are quite separate; in this way the weight of the shaft and its impellers is carried by easily accessible bearings, no grit from the water can get to the journals, and the stuffing boxes are able to perform their own duty without taking any of the load. The tightness of the stuffing box on the suction side of the pump is specially important, and this box is generally provided with a water supply, so that any leakage into the pump will be of water and not air. Figure 7 shows an arrangement of double stuffing box for the suction side fitted with such a water-logging attachment. Those who have heard a high-lift pump when running partly full of air will realize the importance of this, and a comparatively small air leak on the suction side will suffice to prevent the pump from working at all. The pump may be constructed so that water leaking from the last pressure chamber is used to cool the bearings (Figure 9).

The total length of shafting in a motor-driven multiple-stage pump is considerable. It is generally advisable to use a flexible coupling between the pump and motor, so as to allow for any small change of alignment as the pump or motor bearings wear. In small pumps with shorter shafts, solid couplings can be used.

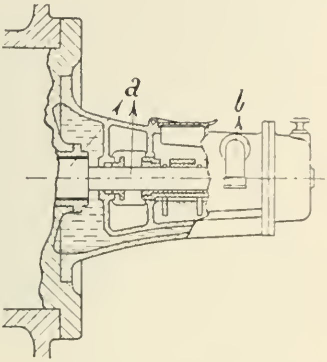

FIG. 9. SECTION SHOWING CONSTRUCTION OF PUMP BEARING.
Gebrüder Sulzer, Winterthur.

Other points requiring attention in design are, the protection of the exposed portions of the shaft from corrosion, for which purpose brass casings are employed; the prevention of leakage from one stage to the next, by fitting brass packing rings, as in the pump of Figure 7 · and the arrangement of the impellers and division plates so as to admit of easy assembly and removal without interfering with permanent pipe joints or connections. The form of the guide passages in the diffusion ring, and the shape of the ports or passages leading from one stage to the suction of the next, have considerable effect on the efficiency of the pump, and on the arrangement of these details much ingenuity has been expended. Provision should be made for measuring the pressure at each stage, so that any serious leakage arising through mechanical injury to one of the impellers or guide rings may be detected and localized. From motives of economy in construction, turbine pumps are usually made up of a series of similar sections, so that successive stages are exactly alike, and a pump to work under any desired head can be made up by assembling a proper number of these units.

The results attained by the modern high-lift centrifugal pump may be stated generally as follows; an efficiency in most cases of from

70 per cent to 75 per cent can be obtained, and under suitable conditions, when the relation between head and discharge is most favorable, this may even reach 80 per cent on trial. These efficiencies are from 5 to 20 per cent in excess of those obtained from pumps without diffusion rings. The pumps can be so proportioned as to give a fairly constant efficiency over a considerable range of discharge. When running light, and discharging no water, the power absorbed is generally from 25 per cent to 40 per cent (see Figure 10) of that required at the rated output of the pump, and is of course wasted in churning the water contained in the pump.

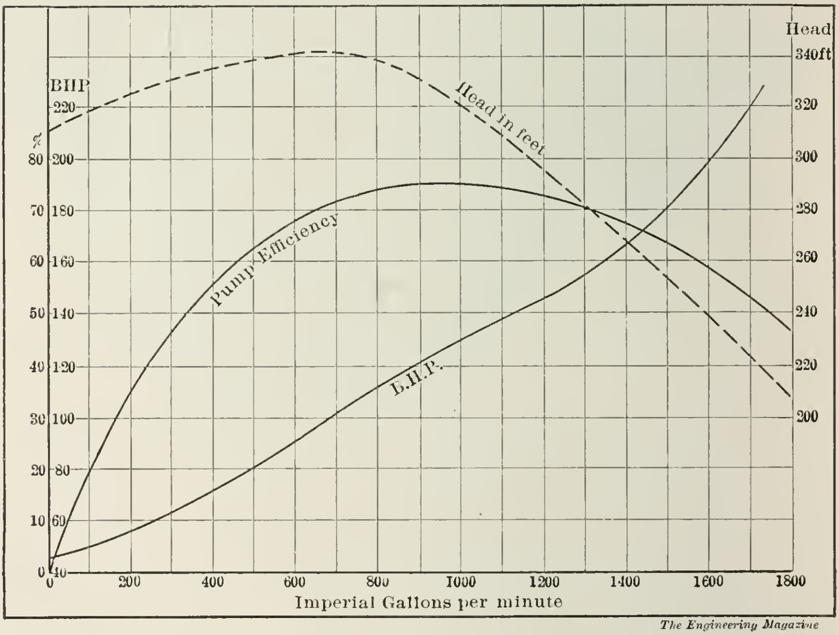

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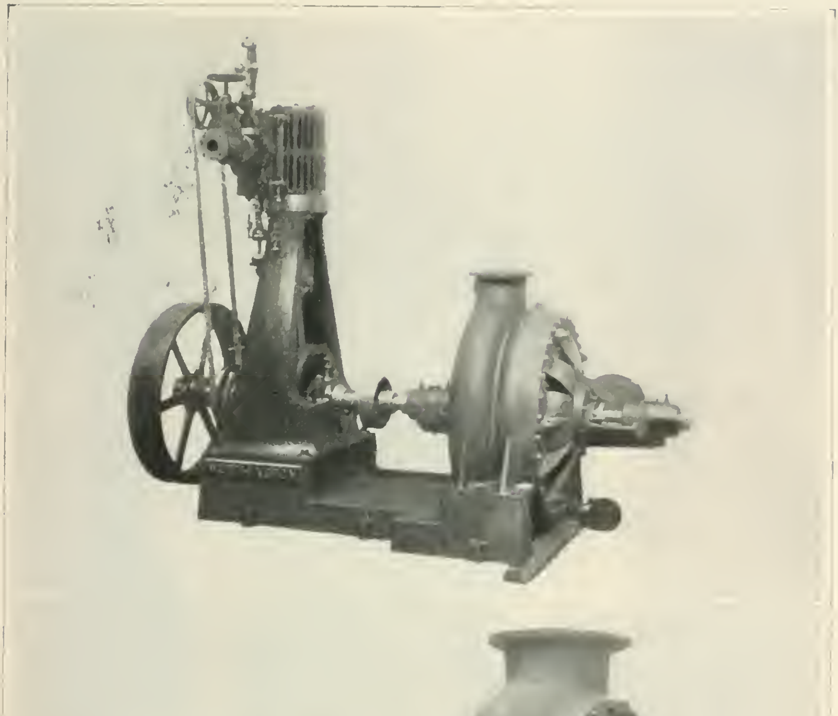
FIG. 10. CURVES OF EFFICIENCY, HEAD, AND BRAKE HORSE POWER FOR FOUR-STAGE PUMP, FOR DE BEERS CONSOLIDATED MINES, KIMBERLEY.
735 revolutions; 320 ft. head; 1,000 imperial gallons per minute.
Mather & Platt, Ltd., Manchester, England.

In good practice the head to be overcome by each stage is from 100 to 200 feet, the lower limit being generally taken where possible. It is found that when the head per stage exceeds 200 feet it is difficult to get good efficiency, because the velocity of the water is so high, and, further, the durability of the pump is diminished, since the impellers and guide blades are liable to injury from a pitting action similar to that observed in the blades of screw propellers. The maximum speed of impeller permissible is also limited by the occurrence of a phenomenon analogous to that of " cavitation " in propellers, and if the impeller



FIGS. 11 AND 12. WORTHINGTON PUMPS—10-INCH ENGINE-DRIVEN AND 16-INCH BELT-DRIVEN.

The latter is single-stage, built for the Colorado Fuel & Iron Co.

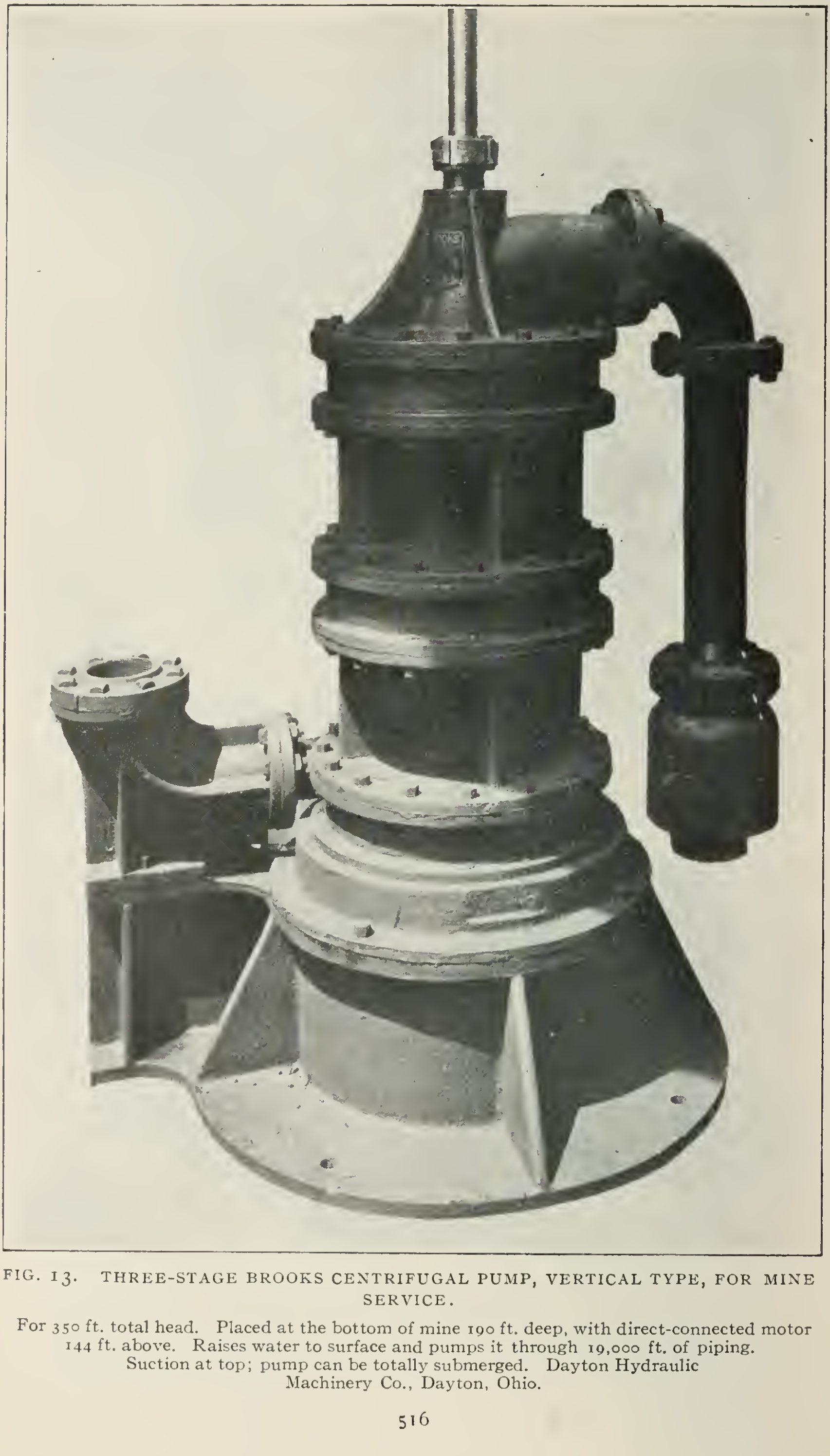


FIG. 13. THREE-STAGE BROOKS CENTRIFUGAL PUMP, VERTICAL TYPE, FOR MINE SERVICE.

For 350 ft. total head. Placed at the bottom of mine 190 ft. deep, with direct-connected motor 144 ft. above. Raises water to surface and pumps it through 19,000 ft. of piping. Suction at top; pump can be totally submerged. Dayton Hydraulic Machinery Co., Dayton, Ohio.

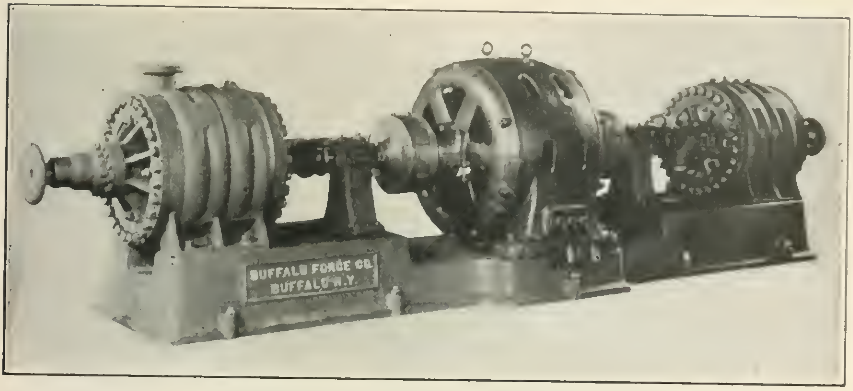


FIG. 14. BUFFALO EIGHT-STAGE 300-GALLON PUMP FOR NORTH-STAR MINES, GRASS VALLEY, CAL.

For 1,400 ft. head; 1,800 revolutions, 250-horse-power motor.

is driven too fast it becomes impossible for the water to flow into the pump suction with sufficient rapidity. The greatest number of stages at present employed is eight, but there seems to be no reason why a greater number should not be used.

It is probable that further progress will soon enable efficiencies corresponding to those of the best water turbines to be obtained, but such results will not be reached without the most careful design and workmanship. The smoothness of the surfaces of the water passages has, of course, an important effect on the efficiency of high-lift turbine pumps. It is unfortunate that these passages are usually of such

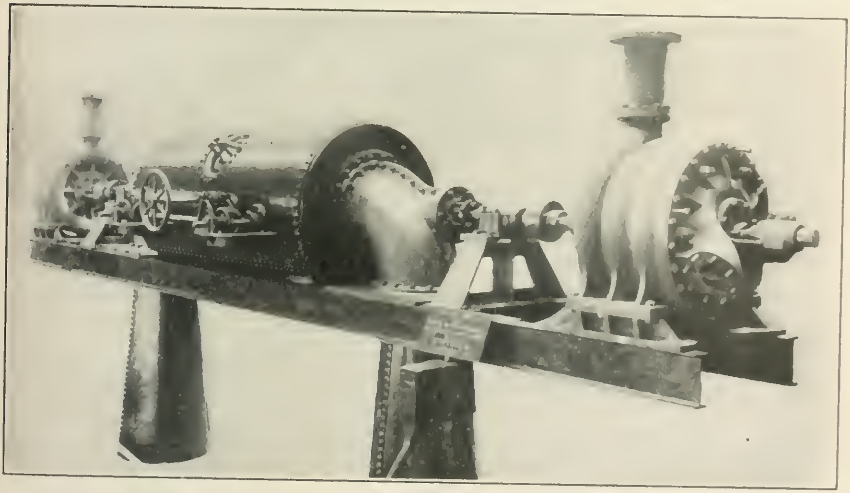


FIG. 15. TWO THREE-STAGE PUMPS, DIRECT-CONNECTED TO HORIZONTAL TWIN MCCORMICK TURBINE.

Can be operated either singly or in multiple; 750 imperial gallons per minute. Built by John McDougall Co., Montreal.

shapes that they can only be finished by hand, and unless of brass, their surfaces are liable to be roughened by corrosion. Tests of turbine pumps after some years' working, however, have shown that when properly constructed there is little or no falling off of efficiency on account of wear and corrosion. Trials of the Sulzer pumps installed at the Horcajo mines in Spain, after one year's running and five years' running respectively, showed the same efficiency, 76 per cent; the head, however, had been raised in the interval from 1,275 feet to 1,575 feet, and the power required increased from 420 to 500 horse power. During this period of service, the time during which these pumps were not running averaged about 16 hours per month. It is worthy of remark that high-lift

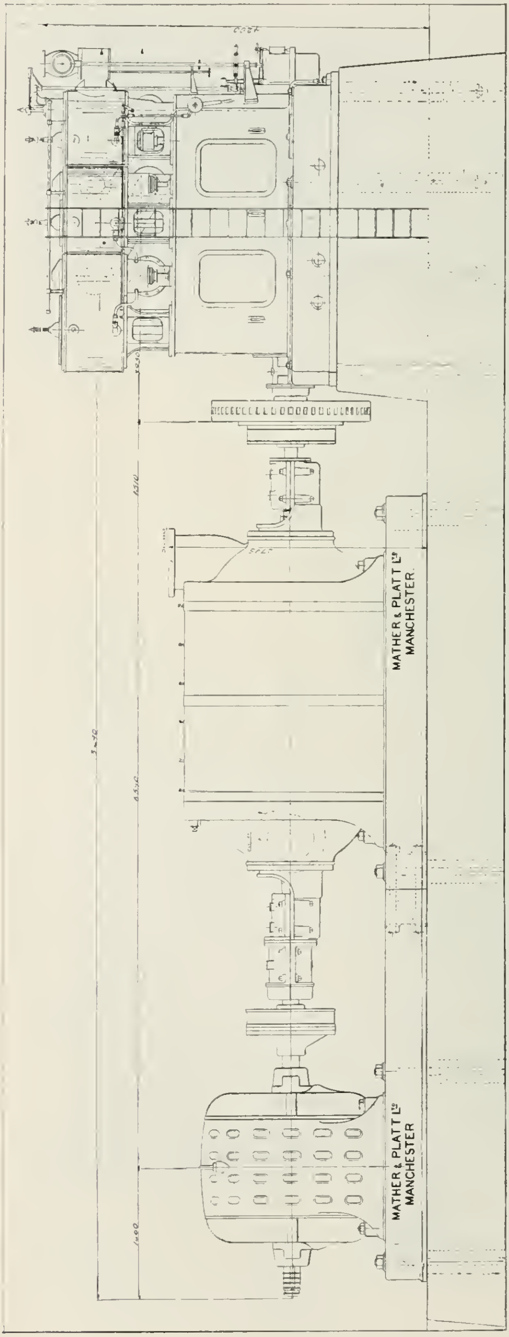


FIG. 16. GENERAL ARRANGEMENT OF 500-HORSE-POWER PUMP, MOTOR AND GAS ENGINE FOR CITY WATER SUPPLY.

4,500 imperial gallons a minute, 300 ft. head, 335 revolutions; three-phase, 63-cycle, 2,200-volt induction motor, rated at 537 brake horse power. Belliss & Morcom triple-expansion high-speed engine, direct-connected; forced lubrication.

turbine pumps can maintain their original efficiency much better than is usual with large piston pumps. The latter are very seldom kept in such perfect condition (as regards tightness of valves and plungers) as to enable their trial results to be duplicated at any time.

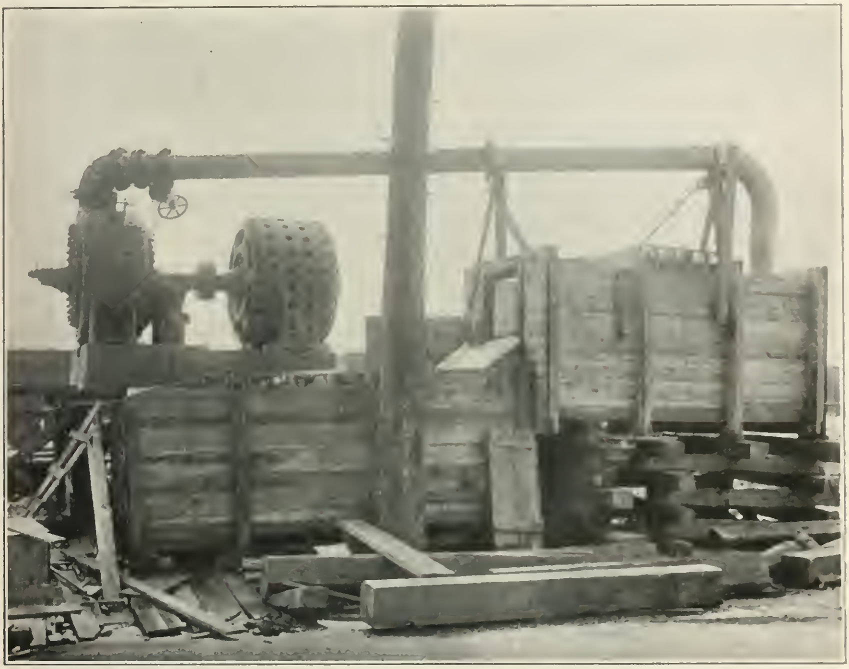


FIG. 17. TWO-STAGE PUMP ARRANGED FOR TEST.

Capacity 6,500,000 U. S. gallons per 24 hours, 710 revolutions, 260 ft. head.
Buffalo Steam Pump Co.

When we consider the expense of installation and maintenance of a turbine pump as compared with a reciprocating pump for the same duty, the contrast is very marked. The 500-horse-power pump and motor of Figures 5 and 16, for example, occupies a floor space (exclusive of the steam engine used as a stand-by in case of failure of the electric supply) only 31 feet 6 inches by 8 feet 6 inches, its capacity is 6,500,000 imperial gallons per 24 hours, or 4,500 gallons per minute, against a head of 300 feet; its weight with bed plate and engine is about 160,000 pounds, and it replaces a three-throw reciprocating pump driven by gearing from a 300-horse-power motor, occupying a floor space of 50 feet by 25 feet, and of nearly twice the weight, although capable of pumping only 4,500,000 gallons per 24 hours. The expense for valve renewals alone for a reciprocating pump of this size would be about $500 per year, and the cost of lubricating oil would probably amount to at least the same sum per annum. The annual cost of maintenance of geared reciprocating pumps is often from 15 to 20 per cent of their first cost. The expense for valves is, of course, non-existent for a turbine pump, and the lubricating oil consumed by a turbine pump should be no more than that required by the electric motor driving it. The foundations for the turbine pump are much smaller and cheaper than those required for the reciprocating pump, and there is no annoyance from the noise and vibration caused by the gearing. Against these advantages we have to set off the smaller over-all efficiency, which in the above case is about 68 per cent at rated load, as compared with say 75 per cent for the reciprocating pump and motor. This means that a turbine pump of the size mentioned above will involve an additional cost for power of from $1,200 to $1,800 per annum, which is more than compensated for by the saving in interest on first cost, depreciation, repairs and maintenance, and in the cost of attendance.

High-lift turbine pumps of the largest size are now being employed for water supply to cities and towns, and several of these pumps have already been illustrated (Figures 5, 7, 8, 16). They should be designed so as to give good results at constant head and through a considerable range of variation of discharge. The pump supplied by Sulzer Bros. to the city of Geneva in 1897 was the first application to this service. Figure 16 shows the general arrangement of the six-stage pump of Figure 5, which is used for city water-supply, and in which a high-speed engine is applied as a stand-by, so that the pump can be driven either by the motor or engine.

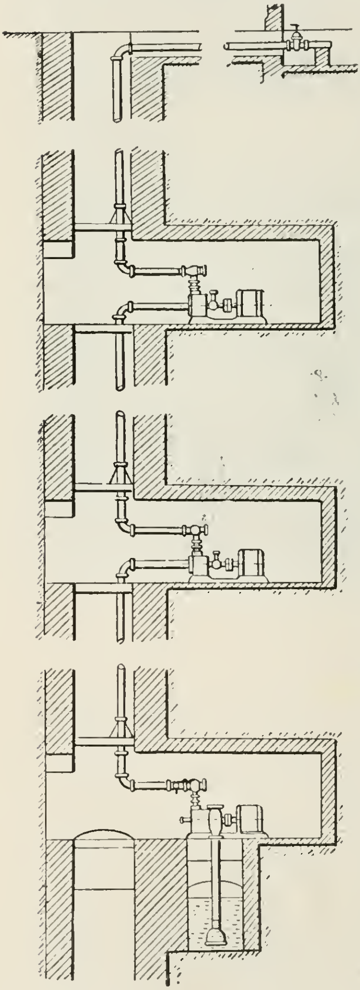


FIG. 18. ARRANGEMENT OF THREE MOTOR-DRIVEN FOUR-STAGE PUMPS, IN SERIES, AT HORCAJO, SPAIN.

Delivering 1,000 imperial gallons per minute against a total head of 1,500 ft. Gebrüder Sulzer, Wintherthur, Switzerland.

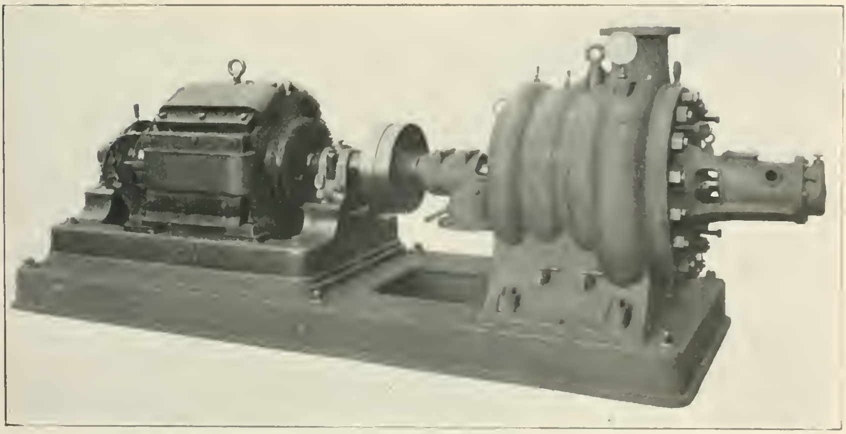


FIG. 19. FOUR-STAGE SULZER PUMP FOR MINE SERVICE.

890 U. S. gallons per minute against 655 ft. head; 1,330 revolutions, 215 brake horse-power.

High-lift centrifugal or turbine pumps have also found extensive use in mines. They are employed not only as permanently installed drainage pumps (Figure 18), placed conveniently in chambers excavated near the bottom of the shaft, but also as sinking pumps,

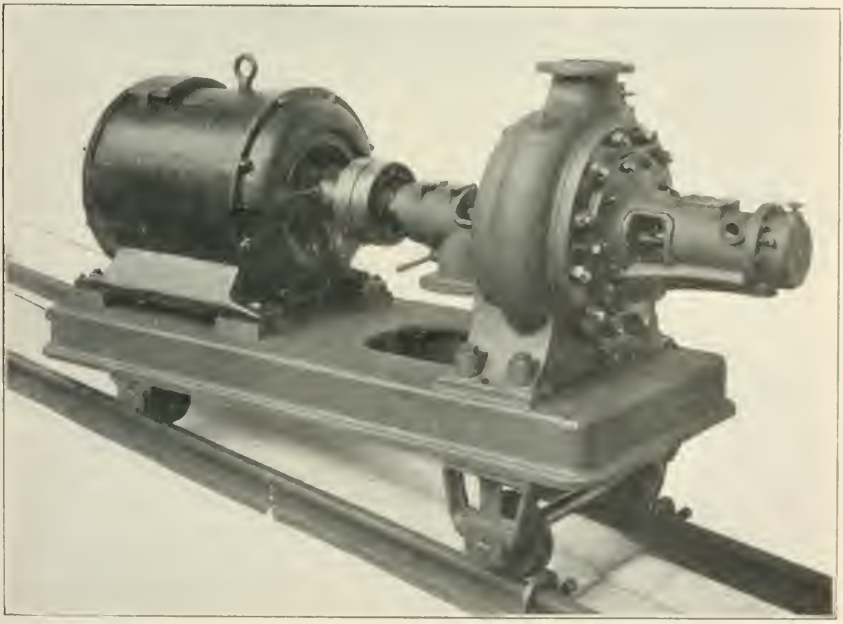


FIG. 20. TWO-STAGE SULZER PUMP FOR WORK IN A MINE DRIFT.

540 U. S. gallons per minute, 1,440 revolutions, 46 brake horse-power.

which can be suspended in the shaft, and even when of considerable power will still leave room for the passage of the cages or tubs of the hoisting apparatus. The sinking pump of Figure 21 is interesting on account of the size and high head, and the method of suspension in the shaft is clearly shown. Special care is necessary in the balancing of these vertical pumps, and for this particular service it is necessary to bear in mind the liability to damage from blasting operations, and the possibility that the pump may have to continue running when lifted clear of the water. The pump of Figure 20 is also a mining pump, and is intended to work in an inclined heading or drift; it can be moved forward as the work proceeds, and current is conveyed to it by flexible leads. The convenience and economy of this arrangement as compared with a pump driven by steam or compressed air is evident.

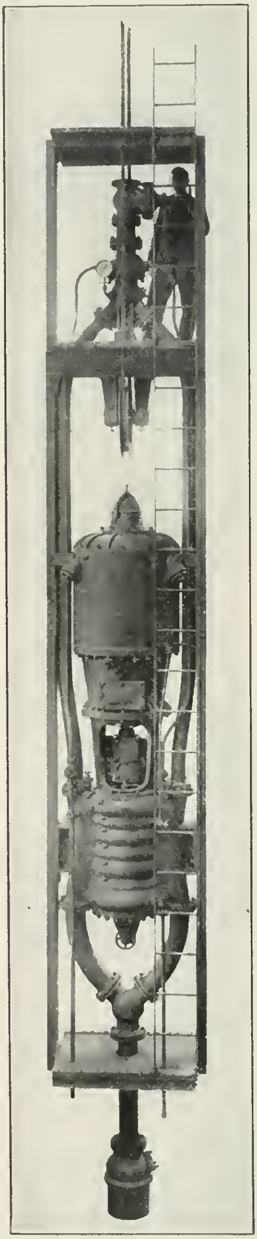


FIG. 21. SIX-STAGE SULZER SINKING PUMP.

540 U. S. gallons per minute against 785 ft. head; 1,458 revolutions, 150 brake horse power.

High-lift centrifugal pumps are finding a wide field of application for purposes of fire protection, both in factories and in cities. A fire-protection system now being installed in Toronto comprises two two-stage pumps of the Worthington pattern, each being directly connected to a steam turbine of 1,000-horse power. This arrangement was adopted because accommodation was available in an existing steam pumping station. The working pressure when the pumps are run as two-stage pumps in multiple is 300 pounds per square inch (700-feet head), but when required they can also be worked as single-stage pumps, giving a pressure of 150 pounds in the mains. This unusually high head for each stage was adopted for the sake of simplicity, and because in the case of a pump which works only occasionally high efficiency is not of paramount importance. The two pumps can deliver 2,900 imperial gallons per minute, and special provision is made for speed control of the turbines.

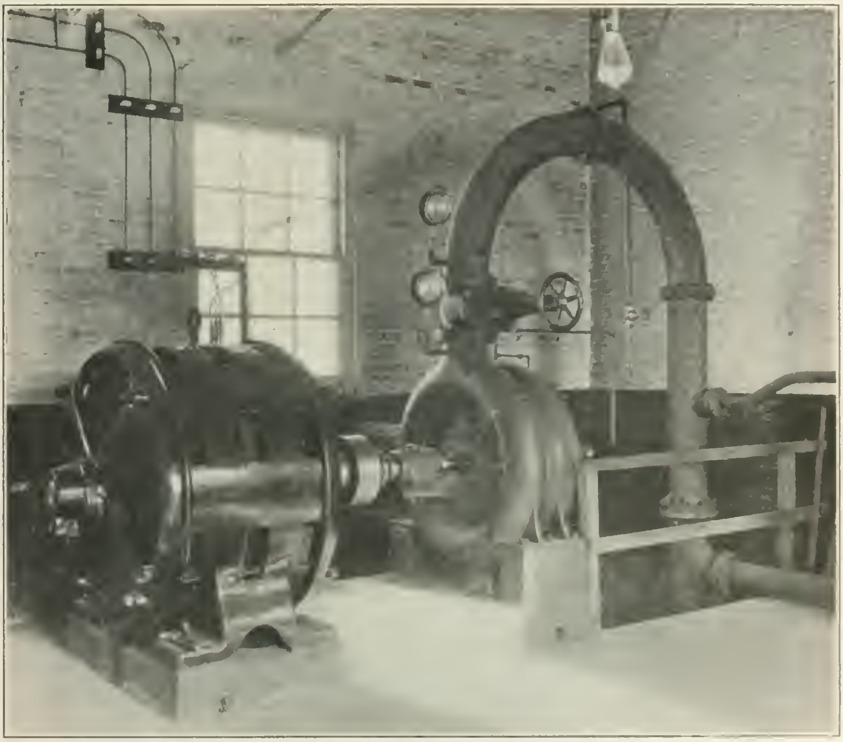


FIG 22. WORTHINGTON FIRE PUMP, INSTALLED IN THE CANADA SUGAR REFINERY, MONTREAL.

1,500 imperial gallons per minute at 150 lb. pressure. Two-stage. Built by John McDougal Co., Montreal.

In Europe high-lift centrifugal pumps driven by electric motors have been used as portable fire engines with considerable success.

For elevator service a motor-driven high-lift centrifugal pump will give good results if arranged with an electrically or mechanically controlled device, so as to vary the discharge automatically in conformity with the needs of the elevator. Such a pump is, of course, incapable of giving a pressure greatly exceeding the normal amount, so that no safety valves are required, and the closing of the main discharge valve cannot cause damage. An elevator pump should be designed so as to give a nearly constant head at all rates of discharge, and the same remark applies to the high-lift turbine pump when used for boiler-feed purposes. It is even possible to use such a pump, of course in conjunction with a dry vacuum pump, for taking water from a surface condenser and delivering direct into the feed pipe of a boiler system. The high vacuum under which the suction side of such a pump is working is not conducive to the most favorable results, how-

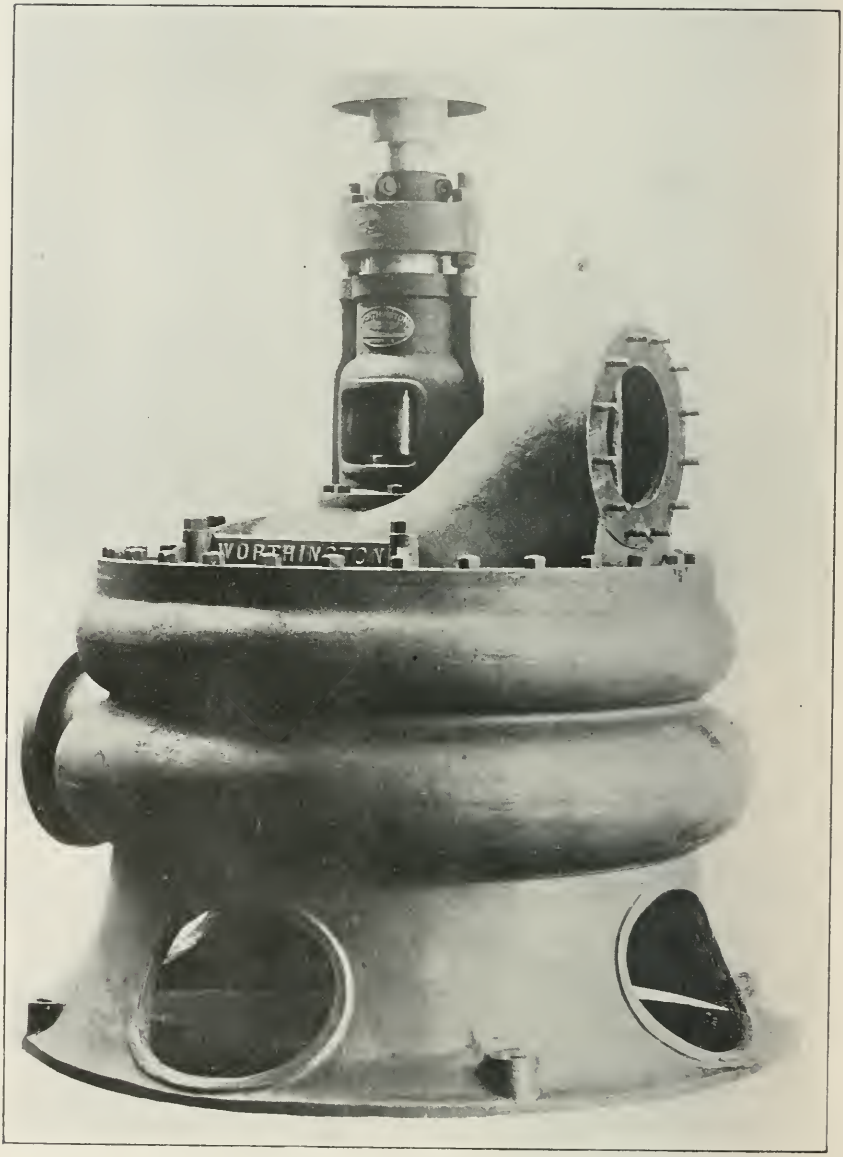


FIG. 23. TWO-STAGE VERTICAL TURBINE PUMP.

Capacity, 10,000,000 U. S. gallons against 100-lb. pressure. Henry R. Worthington, Inc., N. Y

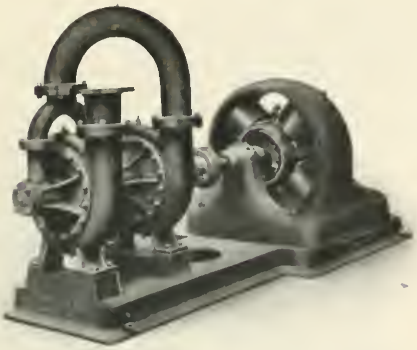


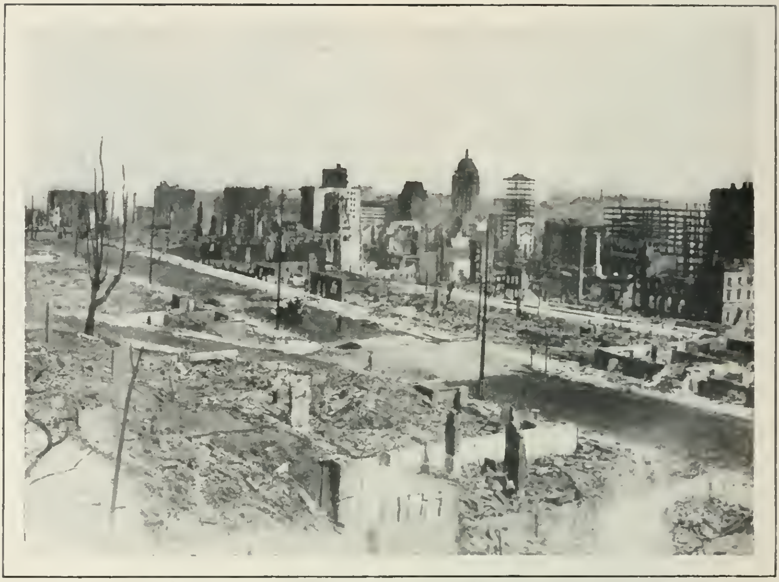
FIG. 24. AN EXAMPLE OF COMPOUNDING BY SEPARATE CENTRIFUGAL UNITS IN SERIES.
Kingsford Foundry & Machine Works, Oswego, N. Y.

ever, even although the water is run by gravity into the pump suction, and great care has to be taken to avoid leakage on the suction side.

A number of successful pumping installations have been carried out in which a high-lift pump has been driven directly by a water turbine. Such a turbo-pump, as built for mine service in Central America, consists of a four-stage Rateau pump having impellers 9½ inches in diameter, and driven at 2,200 revolutions per minute by a reaction turbine placed within the same casing. The 120-horse-power turbine, taking its water under a head of 520 feet, has a single wheel 11¾ inches in diameter, and delivers the water it has used into the discharge pipe of the pump; the pump works under a head of 390 feet and delivers 400 imperial gallons per minute. The combined efficiency of the pump and turbine is 48 per cent, and the machine is arranged so that lubrication can be effected from a level higher than that of the pump, so that it is possible to work satisfactorily with the pump completely drowned.

High-lift centrifugal pumps directly connected to steam turbines are used in many cases and have shown good results as far as steam consumption is concerned, and are giving satisfactory service. Under favorable conditions a consumption of 22.6 pounds of saturated steam per pump horse-power per hour has been shown on a seven-stage pump delivering 900 imperial gallons per minute under 1,180-foot head, and taking, therefore, about 320 horse power. The turbine was of the Rateau type running at 2,200 revolutions per minute with 90-pounds steam pressure, and exhausting into a jet condenser.

Although high-lift centrifugal or turbine pumps have been on the market for only about nine years in Europe, and four years in America, their use has become widely extended. Such pumps are now commercially available for almost any service, so long as the amount of water to be dealt with is not too small in comparison with the head at which it is to be delivered.



STEEL FRAME BUILDINGS—THE ONLY ONES LEFT STANDING IN SAN FRANCISCO.

THE EFFECTS OF EARTHQUAKE AND FIRE ON MODERN STEEL BUILDINGS.

By Clarence Heller.

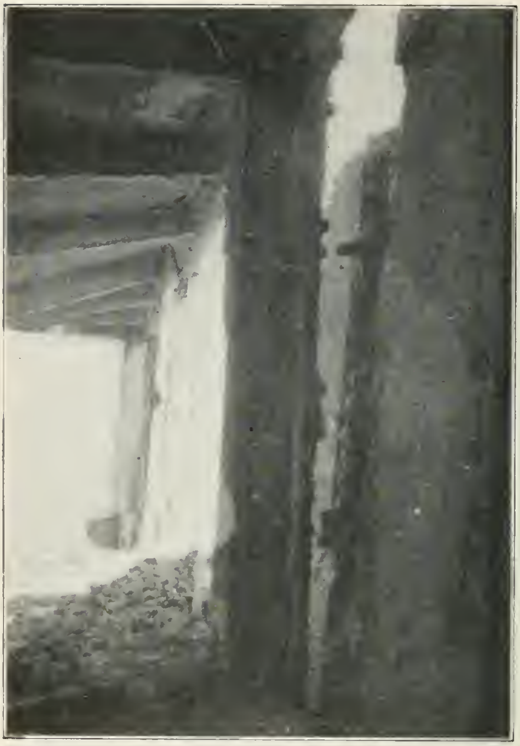
A special interest attaches to Mr. Heller's study—the result of personal observation on the ground immediately after the fire—because of his close record of the details of the failure of structural materials and systems under various conditions. His notes were made from the view-point of a trained observer and specialist in structural engineering; and his photographs, taken with the same dominant idea, aid greatly in bringing the facts graphically before the reader.—The Editors.

On April 18, the buildings of San Francisco were subjected to the violence of two of the destructive phenomena of Nature—earthquake and fire. Only the modern steel-frame structures successfully withstood both, and therefore only they will be discussed at length in this article. At 5.15 o'clock of that morning San Francisco was shaken by the most severe earthquake ever recorded there. The first shock is said to have lasted from 45 to 48 seconds, and it was followed throughout the day by a series of lesser tremors. The steel structures withstood the strains of the vibrations so well that many are already calling these buildings earthquake-proof. This is as much of a misnomer as designating them as fireproof. They are earthquake-resisting, but should a truly heavy or severe earthquake ever occur, the results would not be very agreeable to contemplate.

The shock referred to caused a perceptible damage to many walls, and to the connections of the floor systems when such connections were bolted. The vibrations of the San Francisco earthquake were horizontal and principally in a northerly and southerly direction. There was no upheaval. The motion caused was a swaying or rocking one, which increased in severity with the duration of the tremor. This caused in the lower floors a wrenching or twisting combined with a rocking motion, and on the higher levels a rocking and swaying. The latter suffered less than the former, which seems to indicate that a structure that is not too rigid or stiff is best adapted to resist the vibrations to which it is subjected. Not the height, but the mode of construction is what determines the safety of the building. It should also be recalled that the frame absorbs the vibrations so that as one ascends the higher levels the acute shakings become less perceptible and the swaying motions more pronounced. The introduction of wind bracing therefore becomes an interesting subject, but will not be treated in this article.

It might be mentioned however that in the Union Trust Building, a ten-story building of triangular shape, every piece of sway bracing was buckled. This bracing was made of 2 by 4-inch channels running through two stories and was placed both parallel and perpendicular to the front of the building. The bending always occurred about 3 inches below the gusset plate connecting the two channels.

So well did the steel buildings stand the shock that no improvements on the present mode of construction can be suggested here, unless it be on the veneer walls. Though in general they acted well, a great many will require repair, and others removal. The tendency was to cause cracks between the tiers or to loosen the bricks. Had the shock been more severe, there is good reason to believe that many of the upper walls on the higher structures would have been shed from the frame. Unfortunately there were not a sufficient number of self-supporting walls encasing these buildings to form an opinion. The photograph on the next page shows how such a wall separated from the frame of the Kamm building at the sixth floor. The damage, however, was probably caused more by the rear of the building being dynamited than by the earthquake. While I have always preferred curtain walls where they were feasible, on account of economy and



SEPARATION OF SELF-SUPPORTING WALL AND STEEL FRAME, KAMM BUILDING.

also superior strength in case of fire, it must be admitted that they are not as satisfactory as walls supported at every floor, because any settlement to the earth, or jar due to earthquake, is liable to injure the foundation in the former mode of construction, requiring the complete removal of the entire wall, as was the case in the building above mentioned; while if the latter method is used any one or more sections of the wall may be replaced without injury to the remaining parts.

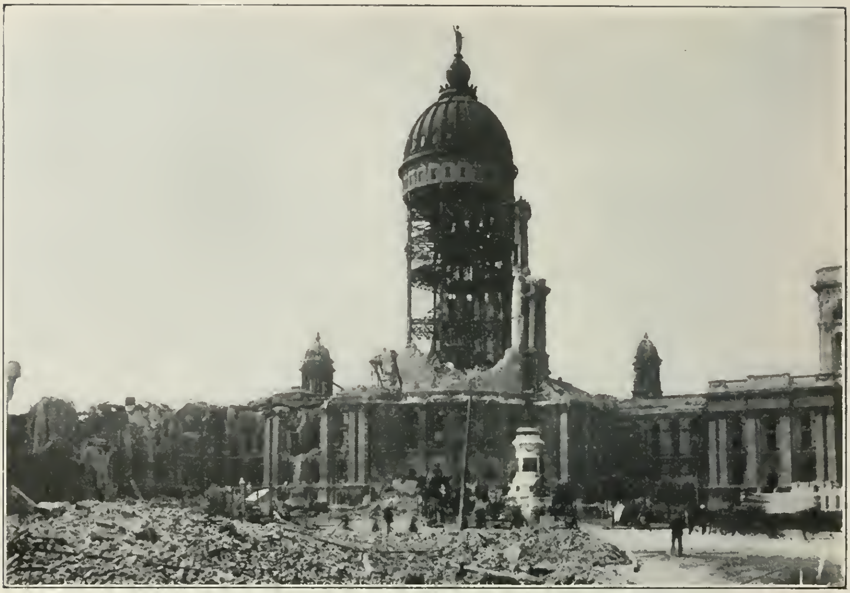
In both cases, however, it is absolutely essential that the walls be securely and frequently anchored to the frame, and when they are constructed of stone or terra cotta the individual pieces should be attached to some part of the metal work. Metal copings and cornices have proven preferable to heavy masonry ornamentation, both in respect to safety and economy. In general, the buildings swayed as a whole, though in many instances floors were cracked by the twisting movements. Reinforced floors, whether strengthened by bars or expanded metal, are better adapted to withstand the vibrations and shocks caused by earthquakes than tile construction, and I am confident that in San Francisco the former will entirely supersede the latter in modern structures.

Of the non-fire resisting buildings, the wooden frame houses were least damaged, the principal loss being caused by the falling of chimneys and plaster. These chimneys were for the most part brick, and unfortunately are being reconstructed in the same old fashion. Evidently only the property loss which they caused, and which was very small, has been considered. But are they not a constant source of danger to life, should another earthquake occur? The next one may occur during the day. These chimneys should be built of concrete reinforced by vertical bars, or if made of brick, the bases should be wider than is now the practice.

While there is no doubt that brick buildings were the most damaged, it is very noticeable that destruction wrought in these structures varied very much even within comparatively small areas. The reason for this is that there was an abundance of miserable masonry. The effect of the earthquake was to crack the walls, starting near the top, or to cause them to sway till at least the upper portions fell out, the roof and floors subsequently collapsing. Walls having frequent buttresses, or cross walls or wide offsets at the base, sustained the least amount of damage. The best example of the latter construction and of exceptionally good masonry, is shown in the accompanying photograph of the ruins of the temple Emanuel, which was erected in 1864—1866. The walls are still standing in perfect condition.

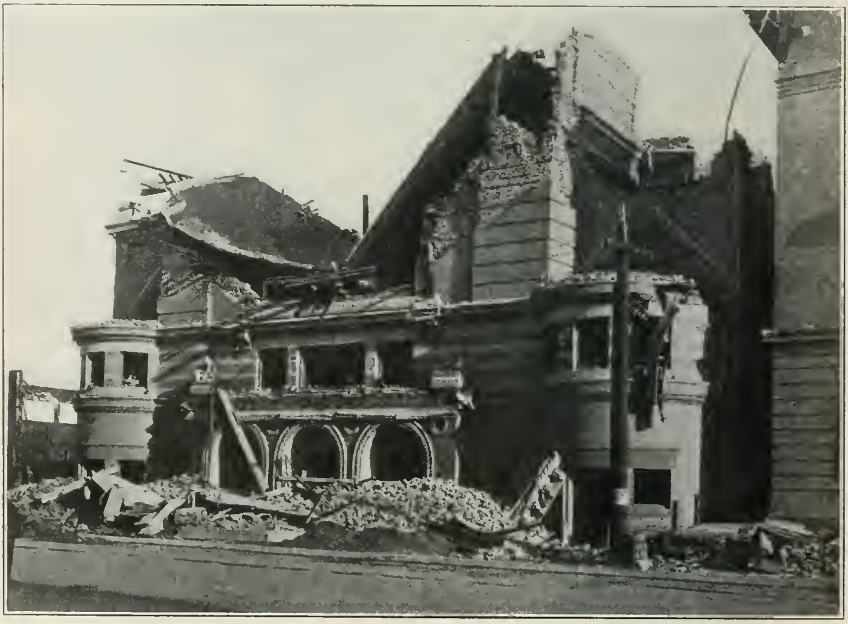
DAMAGE CAUSED BY DYNAMITING. THE REAR OF THE KAMM BUILDING.

Where the walls were well anchored and bonded with good Portland cement, the damage was so very much less than where inferior work had been put in that it is difficult to account for the large amount of poor masonry which existed in San Francisco. It was proven most conclusively that in any kind of masonry, no matter in what kind of a structure employed, to resist either the effects of earthquake or fire.



THE ACTION OF THE EARTHQUAKE ON THE CITY HALL.

This structure was erected at a cost of $7,000,000, taking years to build and furnishing an impressive example of poor masonry.

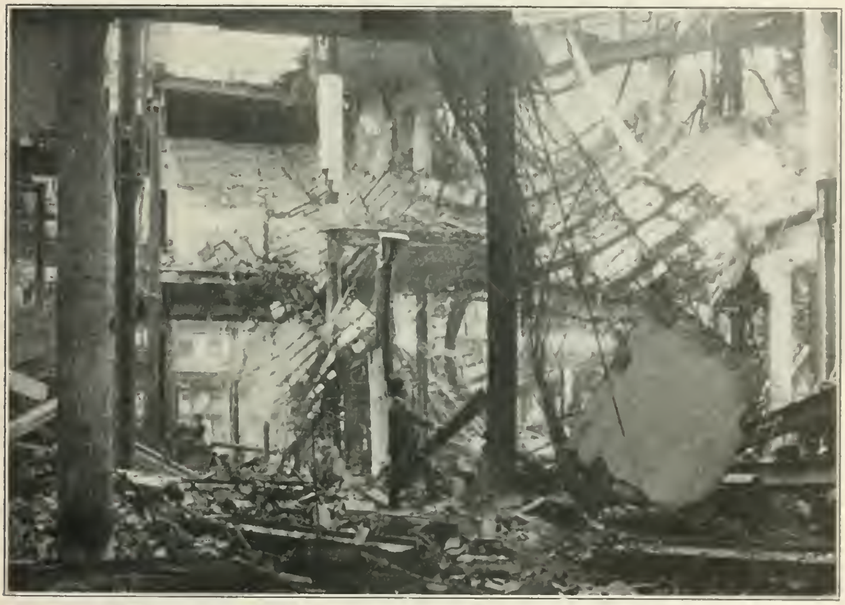


EARTHQUAKE DAMAGE TO CHURCH ON GEARY ST., NEAR STEINER.

Another example of poor masonry.

it is absolutely essential that such construction must use the best material, bonded by good cement mortar, held by frequent anchors and executed by the best workmanship.

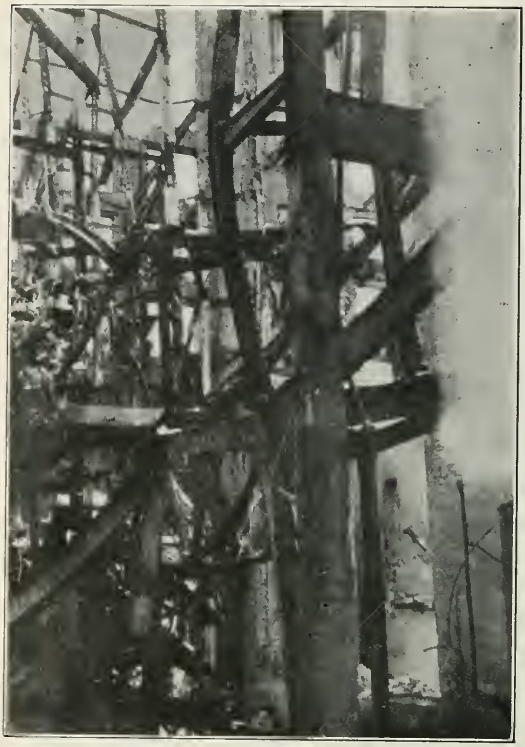
It has been asserted that of the total losses due to the recent calamity, only 2 per cent was caused by earthquake, the remaining portion being attributable to fire. The latter figure includes destruction by dynamiting, which in some of the steel buildings caused the greatest losses. Fire always devoured all the inflammable contents of the building, but when this was well constructed it left the frame and floors intact; while where dynamite was exploded, it completely wrecked the section of the structure in which it was placed.



DAMAGE CAUSED BY DYNAMITE, INTERIOR OF THE EMPORIUM.

This was a department store with offices above.

The San Francisco building laws recognized two types of structures in which iron or steel was employed—Class " A " and Class " B." The first included " all buildings wherein all external and internal loads are transmitted from the top of the building to the foundation by skeleton or framework of steel, and the beams and girders of which are riveted to each other." " Buildings of this class must be constructed of non-inflammable material throughout " except framing for elevators and staircases. " Wood may be used only for window and door frames, sashes, standing finish—and for upper and under floors and their necessary sleepers." The limit of height for such



STEEL IN CLASS B BUILDING, AFTER THE FIRE.

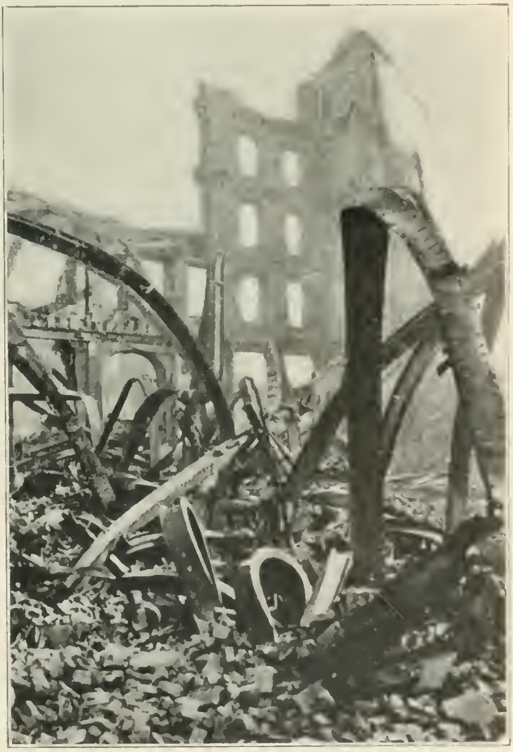
buildings was 220 feet, and where veneer walls were used the ordinance prescribed that they should not be less than 13 inches thick down to the tier of beams next above the curb level, while below this they were to be increased 4 inches for each additional 14 feet. Curtain walls were also permitted. They had to be at least 13 inches thick for the uppermost 60 feet, and then increased 4 inches for each additional 60 feet or part thereof.

Class B buildings were allowed to be erected to a height only of 100 feet, and were constructed with all the "exterior walls and piers of masonry, or of masonry and steel." All metal work was to be protected as in Class A buildings, but in addition to the wood permitted in such structures it was also allowed to be used for "the floor and ceiling joists, posts, roof boards and partitions." A building of this class resembled very closely those of the "mill construction" variety, except that they usually had steel columns for at least two stories of their height.

Class A, of course, represents the most approved form of construction, the buildings of this type being the only ones that were not a complete loss. Of these there are about twenty-three in the city. Many of the Class B buildings would have reflected discredit on any community, and that many of them were occupied as apartment or rooming houses was nothing short of criminal on the part of the municipality that had approved their planning and erection. Though the fire came unlooked for by the citizens, to those who were familiar with local facilities for combating fire, with conditions in the existing buildings and in those that were being erected—to them it was almost daily expected, for in the heart of what other large modern city could so many wooden buildings be found, not to mention the many poorly constructed brick houses?

No better example could be chosen to illustrate the necessity of properly protecting steel work with fireproofing materials than the ruins of Class B buildings. Not only are the structures a complete loss, but the steel which was used in their construction suffered so much from the heat that it cannot be redeemed and used in the rebuilding. The remnants of some of these buildings are shown in the photographs. Now compare these ruins with what is left of the Class A buildings. The inflammable materials in the latter are all destroyed, but the frame still stands intact and the floors are still in position. Occasionally a beam is bent or twisted, but usually not so badly that it may not be rerolled. Is it not therefore false economy to erect a building of which steel forms a large part, and not properly protect it nor introduce fireproof floors?

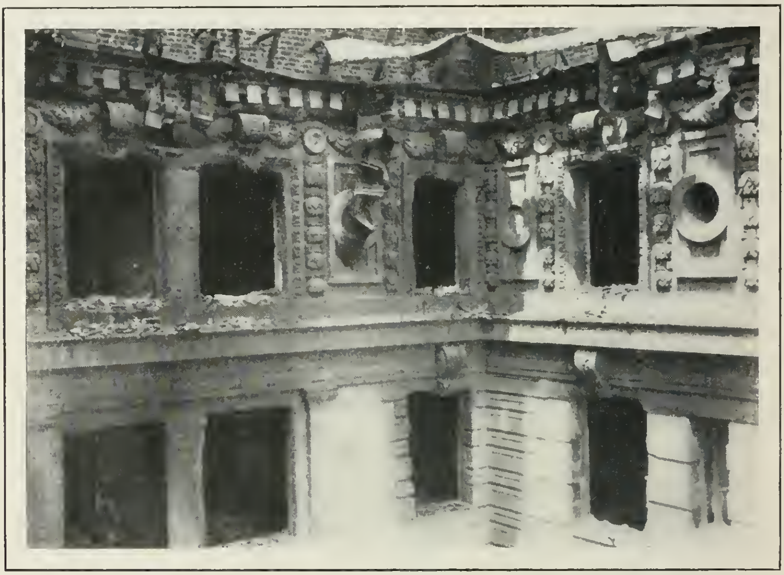
This at once calls attention to the action of heat on the various materials employed in the encasing of steel work. The San Francisco disaster did not afford as good a test for this purpose as the Baltimore fire, for in the Western city the buildings were subjected to an intense heat and then permitted to cool, while in the Baltimore fire they were compelled to withstand both heat and water, causing internal strains. The action of the various materials was for the most part the same. All stone spalled badly, particularly granite. Most of the stone used in San Francisco is a sandstone from Colusa county. Where it



TYPICAL EFFECT OF FIRE ON IMPERFECTLY PROTECTED CLASS B BUILDINGS.

The Terminus Hotel.

came in direct contact with the flames it suffered, like all other stones, but where the heat was more moderate it was not very badly affected. Both brick and terra cotta in exterior walls acted entirely satisfactorily where good workmanship had been employed in their construction.

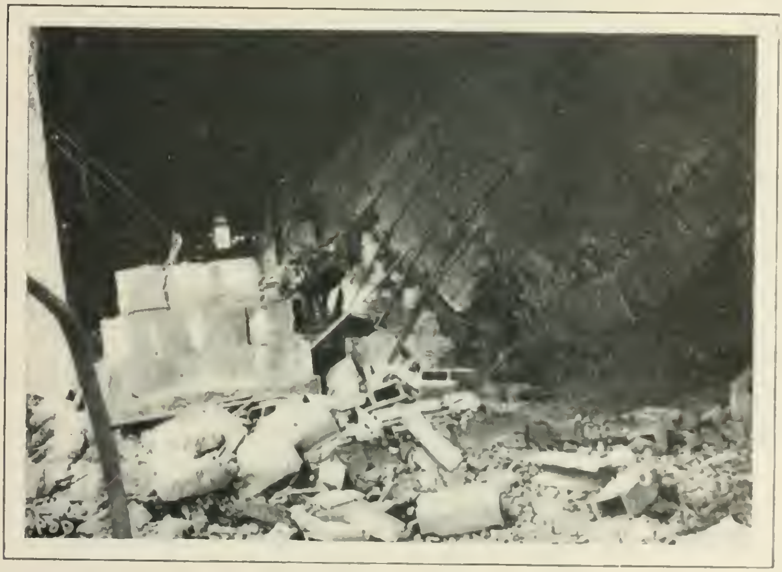


DAMAGE TO METAL COPING, AND SPALLING OF SANDSTONE.
St. Francis Hotel

The majority of the floors systems were of reinforced-concrete construction, except in the older buildings where tile floors were placed. Though the tile appears to be of a good quality, floors made of it required removal more often than those of the concrete type. The tiles generally failed by becoming loose and falling, or by the lower face cracking and breaking off. A very important item in the use of tile construction is that the pieces protecting the lower flanges of the beams should be so connected with the voussoir tiles that they should not become detached and leave the lower flange of the beams or girders exposed. Lack of attention in this matter caused the beams to sag, thereby requiring the removal of both floor and beams. The concrete floors were more successful than those of tile, and not only do they resist the effects of fire well, but the manner in which they are constructed makes them better adapted to withstand the irregular motions caused by earthquakes. Cinder and stone concrete proved their value, particularly the former, both when reinforced by bars and by expanded metal.

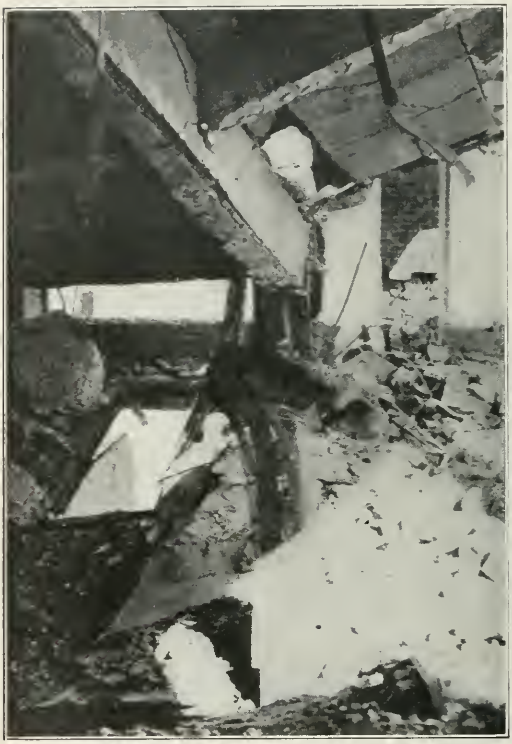
Partitions of both these substances were wrecked in almost every instance, but where built of terra cotta, the blocks were often available for re-use, whereas when built of concrete the salvage amounted to practically nothing.

The action of suspended ceilings in the San Francisco fire was irregular; in some cases they remained intact, while in others they became detached from the beams. Some manufacturers seemed to consider that no covering need be placed about the lower flanges of the beams if the ceiling were suspended from them. Such construction should not be approved, for should the ceilings fail and the fire still continue, there is then no protection to the beams and their failure means the complete loss of the floor system.



TYPICAL FAILURE OF SUSPENDED CEILING AND TERRA-COTTA PARTITION.

The most important steel members seem to have been the ones that received the least consideration, namely the columns. When a single beam fails it necessitates only the removal of the flooring on each side of it, to the next span of beams, and the beam itself can generally be rerolled and returned to the original position. Not so with a column. If a post buckles or in any other way collapses (and this usually occurs at the lower floors) it either tears the girders connected to it away from their connections, or causes a sag in all the adjacent floor above the injury to the column, which means that the strut and the floors surrounding it must be removed and then replaced—a very expensive operation. The strength and safety of the floors and walls depend upon the stability of the columns, so that if they are not to receive the best of attention, what object is there in spending much money and time in protecting the less important members of the frame? In all the Class A buildings that I examined, the damage caused by the failure of the columns was greater than that due to all other causes combined. The loss caused by dynamiting will not be considered. It either threw the columns out of plumb, bent them, or damaged them in other ways so as to render them useless. Fire injured the columns only when they were insufficiently or improperly protected, or when the fireproofing shed.



BUCKLING OF A STEEL COLUMN.

Terra cotta tiles gave the best results. When columns were encased in a solid covering of concrete, they suffered no injury, especially when wire netting was bonded in the concrete. However, such solid enclosures were unfortunately seldom resorted to, the most general practice being to place a single thickness of wire mesh or expanded metal around the column and about 2 to 4 inches from the metal, and to envelop this netting with not more than 2 inches of cement mortar. The flames soon destroyed this coating, leaving the column unprotected; or when the fireproofing was not demolished for the entire length of the column, it was partly removed, creating a flue between the column and its covering. No doubt the theory was that the air space thus established would act as a non-conductor. Such air spaces are valuable, as is shown in the tile construction, but in any case it is necessary that there should be some covering applied directly to the steel itself. When concrete is employed it should be used as a solid mass at least 3-inches thick, or the column should be enveloped in a coating of cinder concrete about 1½ inches thick in which a steel furring has been placed, then an air space of an inch allowed between the first coating and the second. The latter should be at least 1-inch in thickness, and also set on a wire mesh. The outside covering should be anchored to the inner. It is well known that it is advisable not to run piping alongside of the column and within the fireproofing, but many such cases were found. Columns rarely buckled unless subjected to contact of the metal with the flames. It should also be remembered that in office buildings the live load never exists during a fire, so that at such times the columns are called upon to support only about half of the weights they are designed for, which greatly adds to their safety. Where floors supported heavy dead loads and the columns to which they were attached did not have the proper protection, the latter failed while in other parts of the same building, which were used for offices or similar purposes, little damage was done.

SO-CALLED "FIREPROOFING" OF COLUMNS.

The stripping of many columns revealed surfaces much in need of painting, as many had already started to rust, again impressing the importance of proper painting. By far the largest number of columns in the San Francisco buildings were of the Z-bar variety, of which all surfaces are easy of access. The filling of channel columns with concrete might therefore be seriously considered as an extra security against the starting of corrosion. But when steel receives a sufficient number of coats of metallic or graphite paints, properly applied, there is no reason why rust should form.

Steel columns usually failed by buckling or settling, the different pieces of which they were built separating, while cast-iron columns failed by cracking or breaking. Steel posts generally failed just beneath the connections of the floor girders, and not midway between floors, as might be expected, though such cases, of course, also occurred.

AN EFFECT OF THE EARTHQUAKE.

The only two buildings of any consequence that had cast-iron columns were the old Chronicle building and the Sloan building. The former was the first high building erected in San Francisco; it was put up about the year 1889, and was about nine stories high. The posts were about 12 or 14 inches in diameter. The interior is a total wreck, but the walls stand little damaged, so that the columns in them must also be in good shape. The interior columns evidently collapsed, all the floors going with them. The Sloan building acted differently. It was erected in 1900 and was about 100 by 120 feet and seven stories high. The building had concrete floors, all of which were loaded with carpets, rugs, or furniture. In this building all the posts in the center of the structure settled, from the foundations to the roof, an area of about 50 by 80 feet of floor space being completely demolished from top to bottom. The columns sank as a single shaft, and they do not show a defect until the bases are reached. Here they either broke or melted, but such parts are at present covered up with debris so that they cannot be examined. I do not think the foundations sank, as a little of the columns can be seen above the rubbish in the basement and shows where they started to bulge. The beams and girders were torn from the lugs by the bolts shearing, and in a few cases by the breaking of the lugs themselves. The entire building will have to come down. I am told by one of the clerks who worked in the building that it did not show any damage after the earthquake, but that it suffered from fire only. The columns did not, of course, all settle the same amount; but all appear to be plumb, which was not the case in the smaller structures. In such buildings the cast-iron posts showed no injury, or they simply broke off. Still, it must be admitted that they stand the heat better than steel. Breaking of the lugs was common. In low buildings, where wooden joists are to be used, cast-iron columns might be employed to advantage, but undoubtedly they should not be considered for any structures of more than moderate height or importance.

Riveted connections again showed their superiority over bolts, especially when called upon to resist twist by earthquake.

No injury to the foundations of Class " A " buildings was found.

It is not the object of this article to discuss the building laws in force in San Francisco before this calamity, but had they been more stringently enforced, and had the property owners been more willing of their own accord to comply with them, the fire might never had such opportunity to spread as it actually found. Not poor material alone, but bad mortar and miserable workmanship, may truly be said to have caused the greatest losses to the property owners of buildings in San Francisco.

TYPICAL FACTORY SYSTEMS, AND THEIR PRACTICAL RESULTS.

By Egbert P. Watson.

BROADLY speaking, there are at present three systems of conducting factories which may be profitably considered; first, the purely commercial, looking to immediate results at the lowest possible cost; second, the mechanical, seeking the largest turnover that the best outfit of machinery can produce, relying wholly upon automatic devices for success; third, a combination of mechanical perfection with certain accessories in the way of provision for the moral and physical welfare of all the employees throughout the works, whether in the clerical department or elsewhere. I say " moral and physical " designedly, for the reason that the new departures in factory surroundings have, most assuredly, a beneficial effect upon operatives who were not familiar with a better way of living than the one to which they had been accustomed—that found in most workshops where the surroundings are only those demanded by law (and not always those), fostering objectionable habits, disregard of the value of property, contempt of authority, and assuredly striking discordant notes in the general scheme which interfere with the plans and anticipations of the projectors of the new order of factory management.

I have mentioned three kinds of workshops especially which are supposed to produce a staple article; but between these there are others which are run upon what may be called the "catch as catch can" plan, in which costs are an unknown quantity and no sort of system prevails; but these need not be considered here, being without the pale of this discussion.

Taking the first group referred to, an example comes ready to hand in one of the largest and oldest manufacturing plants in its specialty in the United States. It gives employment to thousands of persons, but in all that pertains to an amelioration of the old routine already alluded to there is no change whatever. The shops are provided with the best machines and are operated upon day's work and piece-work plans, but in both of these the payment is not more than will enable operatives to earn an ordinary living in the cheapest quarters and upon the poorest fare; for so soon as piece workers become dexterous enough to earn extraordinary wages, they are cut down in the rate for certain parts and not permitted to exceed about what they could make at day's work. The factory itself is an aggregation of buildings expressly designed for the work to be done, but there is nowhere any other than the usual arrangements for the quartering of thousands of men within doors, and even these are of the most ordinary description and character, and not always in the best sanitary condition. With all this, the place has never come under the notice of the authorities, no attention whatever being given to the conditions by the operatives themselves, who have endured it so long that it has become a matter of course not worth objecting to. It is, perhaps, better to state exactly what the latrines are, for instance; they cannot be called retiring rooms, for there is no privacy whatever in them, a bare room being fitted with a cast-iron trough, or conduit, constantly flushed with water, and this is the sole convenience of the kind alluded to for the thousands of operatives.

When this detail was explained to me by a middle-aged man who had worked in the shop for years I could not credit it, but it remains a fact all the same. Lavatories do not exist, unless a pail of water under the bench can be dignified by that name; these pails belong to the men themselves, but the administration does furnish the water—to both sexes, for the women fare no better than the men. It should be added, however, that this makeshift arrangement is the result of the reckless abuse of much better privileges which were provided by the administration, but it cost so much to keep them in order that they were torn out and replaced by the devices just described.

As a partial explanation of this state of affairs it must be stated that the help is largely recruited from a mixed class of native and foreign-born operatives who are unaccustomed to modern conveniences or any of the usual environments of every day American life.

The immediate surroundings of the factory comprise a few dwellings which are tenantable, but one and two-story houses are the rule; the goat and goose are indigenous and roam over the commons and in the highways; frowsy, unkempt, women quarrel, in strident voices out of windows and over fences, and the whole aspect and impression conveyed to the beholder is depressing to the last degree. They are of all nationalities, "furious Frank and fiery Hun," with a sprinkling of Polacks, Italians, and other races intermingled, who herd together under one roof in this quarter of the town, because they are birds of a feather, and cannot find rooms elsewhere. There are more beeer shops than groceries, apparently, two hundred, a policeman informed me, within the space of about half a mile square, and the normal conditions of life in this settlement are what might be expected—violence and lawlessness, accompanied at times by manslaughter. The morality of the quarter is on a par with the rest of the surroundings, and the police assigned to it earn their salaries in keeping even a semblance of order. With such examples before them it is not surprising that the best workmen will not live in the quarter, but reside in neat homes of their own far away from it.

This factory is on the fringe of one of the oldest cities in the country, and but a short distance from New York; but, although the administration has ample means at its disposal, no attempts are contemplated looking toward remodeling it.

In striking contrast to the shop just described is another one, but a short distance away, which is modern in every sense of the word. Before deciding upon the completed structure, two experts examined all the leading factories in the country critically, adopting the best ideas in them, and adding to them wherever improvements could be made, with the result, in concrete form, of a workshop which challenges criticism—unless, indeed, it be upon the money expended, this detail not having been considered at all. Marble has been largely used wherever it would add to durability and appositeness, even to the partitions between individual urinals; drinking fountains are installed in the main shops, and certain other features which will be mentioned at some length presently; but this is not the only example of the modern factory, for there are others—so many, in fact, that it would require far more space than a magazine affords to describe them specifically.

When, some years ago, certain enterprising manufacturers began to install radical improvements in their shops, it was looked upon by the more conservative as uncertain—in some sense, dangerous,—tending to disturb the relations then existing between employers and employed, by creating a demand for features in plants which, if generally introduced would cost a great deal in immediate outlay and add correspondingly to the fixed charges for up keep and administration. In a few words, the experiment was subversive, unnecessary, and unpopular; but between the time when pioneers in factory reforms started and the present there has been a great change in opinions, and some of the oldest and most conservative concerns are remodeling their plants, and doubling their capacities, in all lines of trade, putting in improvements of all kinds which, if they had been suggested on the outset, would have made even the originators of the movement open their eyes in amazement. One thing leads to another in the reform fever, with the result that no expenditure which promises returns is considered adversely.

It cannot be said that this is mere business rivalry, or expensive advertising; but, as the scheme in its entirety is better understood, it has come to be considered by investors, capitalists, and general managers, absolutely necessary to future prosperity. It is, indeed, a long look ahead to provide for the conduct of a factory, years in advance of increased demand for its product, without foreknowledge of what competition, wars, famine, and acts of the common enemy may bring forth; but this very thing is being done at this moment, in many widely separated localities, by stockholders and managers who will never reap any personal benefit from it, many of them having reached the term allotted to mankind; nevertheless they deem it a wise provision to leave their heirs and assigns. An example is found in a recent press clipping:—

> The Waltham Watch Company, with $12,000,000 capital stock, of which $5,000,000 is to be 6 per cent, cumulative preferred and $7,000,000 common stock, will take the place of the American Waltham Watch Company, the capital of which is $4,000,000.
>
> It is announced that the company will build an addition to its present buildings which will enable it to increase its force of employees from 3,500 to 6,000.

Mere increase of size is not the only change impending, either in the works mentioned or in many others contemplating a similar course; unless all signs are at fault, the workshops of the future will differ greatly in tone and atmosphere from those of the present. But right here, if it were not for the fact that discussions savoring of political economics seem out of place, I should be strongly tempted to enlarge upon one aspect of the new movement in factory conditions which I consider to be the key to success or failure in a marked degree; that is, the personnel of the working force. This view is also advanced by some of the best wranglers of the new *régime*, but it will bear much consideration and discussion, in view of the ship loads of raw material—stiff, intractile, human clay dumped upon the American shores weekly, all of which must be re-washed (literally) sifted, and purged of all impurities before it is available in American workshops for even rudimentary processes. How can we expect that natives of many of the Continental countries will appreciate the institutions of the New World, and comprehend what freedom means, when centuries of oppression and wrongs have upset what few ideas they may have had on the subject? Certainly they will not until they learn to distinguish between liberty and license.

But to return to the main proposition:—in planning a new factory or remodeling an old one, we are careful to see that all the materials entering into its construction shall be of the best quality, testing rigidly the stocks and stones comprising the structure. and employing the best builders to put them together; when the building is completed we install the latest machines and provide conveniences of every sort to insure the comfort of those who are to spend the best part of their lives in running it. We go even further, and supply fixtures and features not demanded by factory laws, so that the workmen may have tangible proof that they are not regarded as part of the mechanical outfit which does the actual labor, but as human beings in whom we have a vital interest, both as regards their moral and physical welfare.

The shop itself is easily kept in good working order at all times, but in the department of labor we are sometimes disappointed in not attaining the results we have spent so much time and money to produce. Our sanitary precautions are not only unappreciated, but actually injured, with malice aforethought, by those for whose benefit they were put in, so much so that the cost of keeping them in order is not small. Painful as it is to be obliged to record these things they must be told in the interest of truth, for this article is not a mere essay upon the topic of which it treats, but is the result of personal observation and conversation with the managers of several modern factories in various parts of the United States and in various lines of manufacture. In all directions I found the same experiences with the actual test of modern systems under working conditions, even where especial pains had been taken in the selection of the help. In the men's departments where most of the trouble originated, complaints of malicious mischief were numerous, but there were none at all in the women's rooms. I said especial pains had been taken in the selection of the help but this should be qualified as I shall show further on by outlining the methods actually taken. and suggesting an improvement in them which would, I think, raise the rating all around, and result in a better average throughout the factory. Just here is the vital point making for success. We are told that a bad workman quarrels with his tools, but I think it should be made more explicit and definite by saying that bad workmen quarrel with *all* tools, and from this aspect of the matter, a shop full of inefficient or disgruntled workmen is a pretty hard outfit to do business with; but, given good will and good faith upon both sides, the question of the permanency of the new departure in factory administration will be answered affirmatively, in due course. This new system, in short, is by no means an outcome of mere business rivalry, leading firms to endeavor to outdo one another in establishing palatial workshops, for that word describes what some of the latest establishments are in the smallest details. In these latest examples there is no attempt at mere display in certain non-essential departments, where lavish expense in the wood work and wall decorations are made up by parsimony in other rooms, but in gross and in detail the finish is as complete in one place as in another. It must be admitted that this principle runs into money, as the saying is, and a great deal of it, so much so that the observer cannot but wonder at the ability of the persons who planned the building to induce stockholders to produce the funds for it and wait, firm in the power of their convictions, to get dividends. Even superintendents with nearly half a century of successful management of well known plants, who are contemplating doubling their capacity on the modern systems, shook their heads when I showed them photographs of the several departments of a new factory. "Our folks have got plenty of money, but they would never stand for this or that, *never, never, never!*" one said, in very positive tones, for the reason that, being a hard-headed man of plain living himself, he could not be brought to see that a marble partition five-feet high between the individual urinals was an absolute necessity in a workshop, or that it had any especial bearing upon the welfare of the individual or the mass, as tending to attract a better class of workpeople to take service.

Be this as it may, those who have established such features know best what their ideals are and how far or when they are likely to be realized, and until they are shown to be impracticable the projectors should not be embarrassed by animadversion. It was not in any unfriendly spirit that the superintendents alluded to commented upon the outfit of the palatial works mentioned previously, but rather as though seeking light upon points which they could utilize in their own improvements..

In further conversation wtih the managers of certain New England factories whose product is known all over the world because of its excellence and low price, I gave the experience of certain factories employing large numbers of work people as to the discipline observed in controlling them, and asked what difficulties, if any, had been found in their own shops, and I was told that there were none of any kind.

"If your people have trouble with their hands," said one superintendent, "it arises from the class of men and women they have to depend upon for their supply of labor. We are in the heart of New England, and have native hands who are by hereditary descent, capable of self-government. They know when they are well-off and do not require to be told what not to do or what they should do; of all things they do not want to be "fathered" too much, or under paternalistic supervision in the shop. Once they understand their duties, they require no watching. If any individual has a grievance of any sort arising from the contact of individual with individual, as will occur even in families at times, they know they have an absolutely impartial judge in myself and they abide by my decision without demur; I have yet to see the first verdict which was appealed from. In proof of this I will mention the labor union question, which was brought up a few years ago, and obtained a certain tolerance from a few hands; but after a full discussion of all sides of the matter in which the union agents had a free opportunity to present their views, our workpeople decided to have nothing to do with it, so we have no unions, but we have an open shop instead, with 'none to molest or make afraid.'

"If capitalists down your way had the same class of men and women to select from, they would have the same results that we do. They ought to come up here and get a few of our "Yankee" girls on their force and they would do better, but I am afraid it would be hard to induce them to leave upon any wages that could be paid them, for some adventurous spirits have tried it upon their own initiative, and returned chastened in spirit with such bad reports of the general conditions which prevailed as to discourage others from experiments. One girl told me that she was present at a public dance to which the conductors of one workshop, having a fine ball-room as a part of its outfit, permitted the help to invite their outside personal friends. At least half of the men were the worse for drink, and one girl as well. This coming to the knowledge of the management caused the public-dance feature to be cancelled.

But as one swallow does not make a summer, neither does one misadventure deter the workshop faculty from continuing their efforts to benefit the class upon whom they have spent their money, yet they have discouragements in plenty if they wished to be influenced by them, and one which recently came to my notice is unique in the history of such events. Among other departments in the very modern and very beautiful establishment already mentioned is a well appointed restaurant where an elaborate bill of fare is furnished to the whole working force daily, for the moderate sum of 20 cents per capita, which, if obtained outside, would command 50 cents for anything like the same value. In brief, there are two joints to choose from, three vegetables, three pies, soup, pudding, coffee, tea, chocolate, milk, bread and butter *ad lib.*, and certain "tiny little kickshaws" too numerous to be listed, all inclusive for the sum named. After a while, what does my lord Disdain among the help do but circulate a round robin to have the kitchen dispensed with, voided, and made of no avail. For why? Because the cooking was bad! In his previous days of mortification of his stomach because of the leanness of his exchequer, he was fain to fill himself with slabs of rye bread and preposterous cheese, given him if he bought about a quart of sour beer; it was either a feast or a famine with him, and on feast days he fared sumptuously on that precarious edible known as the frankfurter, or the still more suspicious viand called bologna. Square meals are an abomination in his sight, so he will none of them and it is uncertain yet whether he will not carry his point. This is only incidental among the obstacles to the welfare work for the employees which has been encountered; inglorious humorists abound among them, only they are by no means mute,—would that they were!

The splendid swimming pool, over 100 feet long by nearly 30 feet wide, 6 feet deep on one end, with a cemented bottom, flanked upon all sides by dressing stalls built of white marble, is neglected by a large portion of the men, although the water can be heated by steam pipes to any desired temperature, because some say that if they want a bath they can get one at home; this seems rather improbable for the reason that as a rule bathing facilities do not abound in tenement houses.

To enumerate all the eccentricities of men who are given privileges to which they are unaccustomed and which they do not welcome, would take too much space; and, as I have already given much of it to them, I will speak of other features in the line of betterments that are such in every sense of the word and are peculiar to the new departure. Recreation rooms and musical instruments for the use of the employees are certainly laudable upon the part of the management, but, like the purely intellectual features, such as the library and reading room, it demands a certain predilection for such forms of relaxation to make them useful to the great body of the help. Be this as it may, the facilities are on hand for those who desire to avail themselves of them.

I said in previous pages that I had a suggestion to make in the line of securing a better class of employees (or grade, if class is objectionable) and this suggestion is to change the method of engaging men and women as workers. At present in some advanced establishments, at least, this is to require them to answer certain questions in a printed list as regards their former occupations, place of residence, parentage, why they left their old places, and if they could return to them if they desired to do so; but I see in this an opportunity for prevarication, and incomplete testimony, unless the averments are verified by officers in the management so that there can be no doubt of the truth of them. The only check at present is a duplicate of the assertions made by applicants, which is forwarded to their old employers, with the request that they certify them correct. I can see some objections to this, not the least of them being the fact that their old employers may not desire to have Richard Roe or Jane Doe hire out to competitors, and consequently may color their replies more or less against or in favor of the applicant, to such an extent that they are useless as establishing the facts in any given case. I lay great stress upon this proposed feature of employing new hands, for persons of objectionable antecedents, if introduced among well disposed work people, can do infinite mischief before they are detected and dismissed. The way to prevent this is to institute searching inquiry in the first instance, to which the honest applicant will not object if there is nothing to conceal, but assuredly will very promptly if there is anything that will not bear investigation, thus making further steps unnecessary at once. It may be urged against this plan that it requires considerable clerical labor of a high class, which is a correct inference; but inasmuch as it is exercised but a portion of the time it is not a costly item in the fixed charges. From another point of view it is justifiable, and this is that it aims to furnish a stable working force that can be depended upon, in contradistinction to a floating one which is the bane of all shops.

In making my observations upon this topic in one of the New England plants just mentioned I was careful to note the personnel employed as regards its outward manifestation in the individual and the mass. I went into a boarding house for both sexes that could accommodate 150 persons, and sat at table with them. The fare was ample in quantity and of excellent quality. The service was quiet and prompt, the table appurtenances, such as linen and utensils, all that was necessary. The behavior of the young people of both sexes was decorous and respectful, each to the other, without any approach to familiarity, least of all to any boisterous behavior on the part of the young men, or inane giggling from the young women; they attended strictly to the business of the moment, and went their several ways when it was over. In the evening I went through the main thoroughfares and found the same attitude in the case of individuals; there were no loitering squads, or gangs as might be said, of young men on street corners, scattering peanut shells and profanity upon all sides; and there was not a single policeman in sight. If this is a New England factory town, I said to myself, it is a pity that it cannot be duplicated elsewhere in the community to the great benefit of the people composing it. It was more: it was an outward and visible sign of the ends the modern factory and its managers strive to attain.

But this was more strikingly manifested in the morning when the workpeople mustered in force. As far as the eye could reach from my point of view on a hotel piazza, the broad sidewalks were crowded with young women eagerly pressing forward " with shining morning faces " on their way to work; singly and in squads they marched, soberly clad in garments suitable to the occasion. Not one had any attempt at cheap finery or was bedizened with gauds of any sort; they looked exactly like what they were,—sober, intelligent, self-respecting young women, self-centered, beholden to no one, calling no man master, animated by a single purpose,—to get to their daily task with as little delay as might be. When the seven o'clock whistle blew there was not a single young woman in sight, they had vanished inside the shop gates " like the airy and unsubstantial fabric of a dream." The whole sidewalk had been occupied by the young women, the men betaking themselves to the causeway upon bicycles; not one that I saw, attached himself to a young woman or attended her to the shop gates. This incident was an object lesson to me, for I realized more fully than ever before what factory towns will be when their plans bear fruit and patience has her perfect work. This will not come in a day or a night, for the abuses of years are not wiped out and forgotten much sooner than it took to create them; but in the fulness of time the frowsy American factory town of today will be supplanted by the thrifty and prosperous one, and the squalid devil-may-care crowds who say in effect: " I go " but go not.

will go actually by the force of the examples set before them by the new factories arising all over the land.

Lest any reader feels that I have spread my palette with too bright colors in this narrative of impending changes, and am over sanguine as to the future, I will say that I know both sides of the factory question—all sides, if I am permitted to defend my statement—for the best years of my life, the early ones, were passed in factories where the conditions were much worse than those which exist anywhere today.

I cannot close this narrative of the aims and, so far, the achievements of the modern factory system with its limited applications in comparison with the large number of shops in the country, better than by mentioning the local pride of the people in the New England town alluded to in the character of the operatives who comprise the largest part of it. When I inquired into their general status and morality there was but one answer: "of the very best." Trolley cars ran frequently during morning hours directly to the works, but they were not fully loaded; how it was at the end of the day I did not see, but was told that many of the young women walked both ways, to and from the shop, both trips, averaging two or three miles daily; if there is to be an universal brother (and sisterhood) of man I feel safe to say that it will have its inception in the town of Waltham, Mass., for the social conditions favor it. The attitude of the operatives toward each other is more like that of the family in its best estate, than of factory "hands" so-called, where the beatitudes are unknown, and everyone's hand is against the other. Philanthropy and business have joined hands with the result that both thrive.

A STUDY OF ELECTRIC-RAILWAY OPERATING COST AND REVENUE.

By H. S. Knowlton.

Comparison between various systems is greatly facilitated by reducing the figures to the unit basis, and in electric-railway work this can readily be done without passing beyond the range of the actual financial quantities which bear directly upon the business transactions between each company and its patrons. The production of transportation is essentially a manufacturing process. Passengers and freight constitute the raw material at the point of departure; by the application of the railway company's equipment, location value is conferred until at the point of destination the finished product stands complete and ready for service. The cost of handling passengers and the revenue thereof, in urban street railway practice, may therefore be analyzed on the basis of the car-mile, the mile of track, the population served or the passenger carried just as in central station operation the cost and returns may be expressed in terms of unit output or plant rating.

THE cost of operating a modern street-railway system and the relation between its earnings, equipment, and traffic, constitutes one of the most favorable subjects for analysis in the field of engineering finance. The facility with which such an investigation can be made depends largely upon the extent to which unit quantities are employed in exhibiting the figures under consideration, and in electric-railway work, more than in any other commercialized branch of applied science, the unit method of analysis corresponds closely in its figures to the actual sums which enter into the business transaction between each company and its individual patrons.

It recently occurred to me that a study of the operating cost and revenue of four representative urban street-railway systems on the basis of the mile of main track operated, the car mile run, and the passengers carried, might furnish material for instructive comparisons. The recently published annual report of the Massachusetts Railroad Commission offers a wealth of material as to the items of total operating cost and revenue of the many street railways in the State, but it naturally does not present much detailed analysis on the unit basis. In the desire to display the results indicated, the system of Boston, Worcester, Springfield, and Pittsfield were selected as representative urban street railways of varying size, and for the purpose of further contrast the typical interurban line between Boston and Worcester was added to the list analyzed. Throughout the preparation of the figures it was realized that statistics of this character applied to systems of diverse conditions cannot be accepted as entirely conclusive in all particulars, but it is believed that any additional light which can be thrown by contrast upon the cost of electric transportation is worth while.

The Boston Elevated Railway Company's system is one of the largest in the world, and is essentially urban in all its features. At the end of the last fiscal year, Sept. 30, 1905, the company operated 398.2 miles of main track, employed 7,471 persons in its service, and owned 3,325 passenger cars. A large part of the company's trackage lies in the suburban cities and towns immediately surrounding the city of Boston, proper, but it cannot be said that these suburban lines partake in any sense of rural characteristics, for the reason that the Boston suburbs correspond simply to the purely residential sections of any large self-contained city. It is no easy matter to determine the tributary population of so complex a system, which illustrates in its several divisions almost every kind of a route known to the urban electric transportation field--surface, subway, elevated, boulevard, and subaqueous tunnel. The population of Metropolitan Boston, according to the State census of 1905, is more than 1,300,000, limiting this area to a radius of 10 miles from the Massachusetts State House. Probably the vast majority of these people are frequent customers of the Boston Elevated system, despite the strong competition of steam railroads operating in the same territory. At the same time it seems fair to allow only the population of the cities and towns within whose limits the company's tracks are actually in service, and on this basis, the tributary population of the Boston Elevated is approximately 972,000. This method of estimating was followed in the case of Worcester, Springfield, and Pittsfield.

On Sept. 30, 1905, the Worcester Consolidated Street Railway Company operated 138.7 miles of main track, employed 753 persons, and owned 310 passenger cars. The population of Worcester is 128,000, but the consolidated system operates in some seventeen other Worcester county cities and towns which bring the tributary population up to a maximum of 245,000. A considerable portion of the company's mileage is rural, and in many of the smaller towns it is doubtless true that persons living at a remote distance from the company's tracks seldom patronize the cars. At the same time, this number must be only a very small percentage of the estimated tributary population, and when we consider the revolution in rural life which the trolley has helped to bring about, we are probably not going far wrong in counting every inhabitant as one of the tributary population, even though the remote resident may be only a potential patron. Certainly the occupant of a farm distant two or three miles from a rural trolley line should be counted as a tributary resident, as well as the suburban business man who lives on the very car line of the city system but depends on the faster, less frequent, and more expensive steam railroad service to carry him between home and office.

The mileage of the Springfield Street Railway Company is 87; employees, 500, and passenger cars, 227. This system is largely urban and suburban in character, resembling the Boston Elevated more than the Worcester Consolidated, although on so small a scale that the comparison cannot be pushed very far afield. The population of Springfield is 73,540; the estimated tributary street-railway population 129,000. The Pittsfield Street Railway operates 26.7 miles of main-line track, has 82 employees, and owns 34 passenger cars. Its territory is somewhat like that of the Worcester Consolidated, consisting of the urban centre and outlying radial village or rural sections. Pittsfield's population is 25,000, and the estimated tributary population is 31,700.

The Boston and Worcester Street Railway is probably the most representative interurban line in New England giving high-speed service. It connects the two cities named by an air-line route, and has but two branch lines of any consequence. It operates 73.6 miles of main track, has 230 employees, and owns 67 passenger cars. Excluding the terminal cities, the tributary population of the Boston and Worcester is 93,600; if one included the total population of the terminal cities, the tributary population would be upwards of three-quarters of a million—manifestly an absurdity. It was therefore considered best to omit per-capita statistics in the study of this line, for in my opinion even an approximate estimate of the tributary population is little more than a guess. The company's tracks do not extend into either terminal city, its cars being handled by the local company at each end.

Table I. on the following page gives a general survey of the earnings and expenses of the five systems.

In this table item b covers receipts from carrying mails, merchandise, tolls, rents, and advertising. As would be expected, the great bulk of the traffic is passenger service. Item d includes all general expenses, salaries, wages, insurance, legal expenses, power cost, maintenance, removal of ice and snow, damages, and rents. Item h covers taxes, interest, payments to sinking funds, and similar deductions.

TABLE I.

	Boston Elevated	Worcester Consol.	Springfield St. Ry.	Pittsfield St. Ry.	B. & W. (Inter'b'n)
a. Gross Earnings from Passengers	$12,337,867	$1,362,749	$999,492	$161,465	$443,098
b. Other Earnings from Operation	351,808	16,266	13,903	120	5,267
c. Total Earnings from Operation	$12,689,675	$1,379,015	$1,013,395	$161,585	$448,365
d. Operating Expenses	8,617,653	821,679	719,335	115,058	229,655
e. Net Earnings from Operation	$4,072,022	$557,336	$294,060	$ 46,527	$218,710
f. All other Income	51,893	....	....	50	....
g. Total Income	$4,123,915	$557,336	$294,060	$46,577	$218,710
h. Total Charges on Income	3,288,831	361,312	151,886	28,724	113,649
i. Net Divisible Income	$835,084	$196,024	$142,174	$17,853	$105,061
j. Dividends	798,000	195,250	156,672	15,000	103,494
Surplus	$37,084	$ 774	....	$ 2,853	$ 1,567

These figures show at a glance the financial operation of the business of each company as a whole, but to ascertain the operating cost and revenue per capita handled, or better, per passenger, we turn to Table II.

TABLE II.

Cents.	Boston Elev.	Worces- Consol.	Springfield.	Pittsfield.	B. & W.
Gross Earnings per passenger	5.00	5.00	5.00	5.00	5.00
Other "	.14	.06	.07	.00	.06
Total Earnings from Operation	5.14	5.06	5.07	5.00	5.06
Operating Expenses	3.50	3.02	3.60	3.57	2.59
Net Earnings from operation	1.64	2.04	1.47	1.43	2.47
All Other Income	.02	....	....	....	....
Total Income	1.66	2.04	1.47	1.43	2.47
" Charges on Income	1.33	1.33	.76	.89	1.28
Net Divisible Income	.33	.71	.71	.54	1.19
Dividends and Surplus	.33	.71	.71	.54	1.19

In this table no attempt was made to carry out the figures to the third decimal place, so that the quantities tabulated are only approximate in the second place. It must be borne in mind that in the case of the Boston Elevated the total charges on the income include the dividends paid to the stockholders of the West End Street Railway

Company in connection with the Elevated's lease of the company's surface lines in Boston.

The volume of traffic and the car mileage of each road in the year ending Sept. 30, 1905, is shown in Table III.:

TABLE III.

	Boston	Worcester	Springfield	Pittsfield	B. & W.
Revenue Passengers	246,941,776	27,722,407	20,093,967	3,245,211	9,110,182
Car Miles...........	48,069,404	5,079,865	4,806,894	687,299	1,820,575
Tributary Population (estimate)........	972,000	245,000	129,000	31,700	.....
Tributary Population per mile Track....	2,440	1,770	1,485	1,188	.....
Revenue Passengers per Mile..........	620,175	199,831	230,920	121,512	123,746
Rides per Capita.....	254	113	155	102	......
Revenue Passenger per Car Mile......	5.13	5.45	4.16	4.73	5.
No. Employees per Mile Track........	18.8	5.4	5.75	3.07	3.1

The Boston and Worcester per capita figures were not attempted. Transfer traffic is not included in the above data.

Tables IV and V show the principal financial items of expense per mile of track and per car mile. It was not thought necessary to present the figures in extenso, the intention being simply to compare items of special operating interest in the different systems:

TABLE IV.

	Boston	Worcester	Springfield	Pittsfield	B. & W.
Gross Earnings from Oper. per Mile Track.	$31.800.	$9,930.	$11,600.	$6,050.	$6,100
Oper. expenses per Mile Track...............	21,600.	5,910.	8,220.	4,305.	3,120.
Net Earnings per Mile Track................	10,200.	4,020.	3,380.	1,745.	2,980.
Operat'g Ratio(exp.-gross) %............	67.9	59.6	71.0	71.2	51.2
Wages per Mile Track...	$9,670.	$2,080.	$ 3,030.	$1,292.	$ 970.
Cost Motive Power per Mile Track..........	2,180.	1,353.	1,570.	1,310.	827.
Car and Vehicle Repairs per Mile Track.......	1,221.	394.	675.	267.	301.
Car Eqpmt Reprs. per Mile Track..........	855.	285.	643.	658.	261
Mainten. of Way per Mile Track...............	1,872.	195.	750.	267.	118.
Mainten. of Line per Mile Track...............	398.	89.50	175.	4.70	31.20
Legal Expenses per Mile Track...............	784.	24.50	57.80	57.	.....
Insurance per Mile Track	439.	146.	74.60	37.80	109.
Taxes per Mile Track....	2,640.	765.	922.	326.	450.
Dividends (incl. W. E.St. Ry.) per Mile Track...	5,000.	1,401.	1,800.	562.	1,400

TABLE V.

(All figures are in cents.)

		Boston	Worcester	Springfield	Pittsfield	B. & W.
Gross Earnings	per Car Mile	26.4	27.1	21.1	23.5	24.7
Oper. Expenses	" " "	17.9	16.1	15.0	16.7	12.6
Net Earnings	" " "	8.5	11.0	6.1	6.8	12.1
Wages	" " "	8.0	5.7	5.5	5.0	3.9
Motive Power	" " "	1.8	3.7	2.8	5.1	3.3
Car Eqpmt Repairs	" " "	0.7	0.8	1.2	2.6	1.0
Maint. of Way	" " "	1.6	0.5	1.3	1.0	0.5
Maint. of Line	" " "	0.3	0.2	0.3	..	0.1
Legal Expenses	" " "	0.6	..	0.1	0.2	..
Insurance	" " "	0.3	0.4	0.1	0.1	0.4
Taxes	" " "	2.1	2.1	1.6	1.3	1.8
Dividends	" " "	4.1	3.8	3.2	2.2	5.6

The foregoing figures are significant in many ways, but only a few points can be touched upon in the remaining space. One of the most striking conclusions to be drawn is the very high cost of street-railway operation in large cities, especially in the direction of the number of employees necessary and the maintenance of way. On the Boston Elevated there are from three to six times as many employees per mile of track as on any of the other systems, and yet the Boston system has a world-wide reputation for able management. It is impossible to escape the conclusion that the enormously greater maintenance of way charge per mile in Boston is largely induced by the city vehicular traffic which is run over the rails in great volume, although high standards of construction doubtless enter the situation. It is interesting to note that although the cost of motive power per mile is largest in Boston, it is also least per car mile in that city. The high cost of power per car mile in Pittsfield is doubtless due to the purchase of power from the local electric-light company.

It is evident that one must know about how many different features of service before attempting to judge the financial performances of a given road. The car-mile earnings of the Boston and Worcester interurban line are excellent in comparison with all the city systems. but this must be due in part at least to the relatively infrequent headway of the interurban cars. The cost of operation on the Boston and Worcester has been kept well down, considering the volume of its traffic. It would seem that the Springfield traffic is somewhat denser than that of the Worcester system, and this is doubtless due to the greater proportion of city track in Springfield.

The figures show very well how the rides per capita increase with the population, as does the traffic density. The low cost of car-equipment repairs in the larger cities is doubtless in part due to their superior shop facilities. It is worth noting than in Boston taxes amount to more per car mile than either motive-power cost, car-equipment repairs, maintenance of way or line repairs, and in no city were the taxes an inconsiderable portion of the operating expenses. The larger the city, the higher were the wages per car mile. This is probably due to two factors: the actual higher usual rate of compensation and the slower schedule speed. It is very plain that on an interurban system increase of traffic is greatly to be welcomed, and probably it is relatively more profitable on a line with a private right of way than on a purely street-railway system. It is important to bear in mind that the profits above the cost of operating a street-railway system in a small city are by no means inordinately great at the present time, and that while a large urban street-railway system properly handled ought to be exceedingly prosperous judged by the traffic density, it requires the most careful management to keep the expenses down to reasonable amounts. Fixed charges, and especially taxes, amount to enormous totals in the operation of a great system; legal expenses and damages, the cost of inspection and wages are bound to be high. The figures presented plainly indicate the increasing complexity of living in the great city as compared with the small community, and they also indicate the wisdom of considering every expense in a transportation system important, even though it appears small in unit items. Wages, taxes, power, and maintenance are the fundamentally expensive items of street-railway service as analyzed herein, but the other quantities tabulated are in no sense negligible. It is hoped that the data presented will be suggestive to those interested in studying the cost of urban electric transportation. A yearly study of any given system along these lines ought to be extremely helpful in determining where the cost of operation may be decreased, and how far short the earnings fall below the experience of similar properties.

THE PRACTICAL ASPECT OF ENTROPY.

By Dr. Jos. H. Hart.

In this article, as in a preceding one upon mechanical refrigeration which we published in May last, Dr. Hart follows the clear and interesting method of using well-known analogies and parallels in mechanics and physics in order to make clear a conception not so easily grasped by the average mind. His demonstration of the significance of entropy will be welcomed because of this clearness as well as because of the importance it has in the fuller practical study of thermodynamics.—The Editors.

TO the majority of engineers, the statement that compressed air contains no more energy than the ordinary atmosphere is apt to prove a matter of considerable surprise; and the further statement that the purchase of compressed air means the purchase of entropy rather than energy brings the average man at once to an interesting but rather hazy subject. The conception of entropy is very incomplete to the ordinary engineer, and while many know what a beautiful and very efficient tool it has become in the analysis of the losses in steam work, very few have any clear-cut, concise ideas in regard to its nature, and its utilization has become in the majority of cases a stilted following of certain simple well defined rules. The reason for this condition of affairs is two-fold. Until recently, very little was known about entropy by anybody, and what was known had little or no practical significance. In the second place, the training of the ordinary engineer was not such as to render easy the acquirement of this knowledge, which was hampered by the technical terms and methods of the physicist and mathematician. At present, however, the conceptions in regard to entropy are clear and distinct, its field of usefulness is gradually and steadily expanding, and it has become indispensable in some of the modern developments of physics, engineering and chemistry.

Now, the entropy of a substance is defined as the ratio of the quantity of heat or energy in a substance to the temperature of the substance. There is nothing radical or unusual in this definition. Similar ones are used every day and present no difficulties in their conception and utilization. Thus the definition of density is that it is the ratio of mass to volume. The constant and steady use of this physical constant, combined with the fact that we have simple and accurate methods of readily measuring it, have led to an easy realization of its physical significance and use. In the same way, electrical resistance is defined as the ratio of electromotive force to current, and it is only due to its continued and steady use that we have come to conceive of it as a distinct and separate property of matter, analogous to the friction in pipes for a stream of water flowing through them. The importance of having simple and rapid instruments for measurement in such cases cannot be overestimated. Without the ability to measure readily either density or resistance, both of these physical constants would be in a position analogous to that of entropy, and would be equally difficult of conception and utilization. The facts with which we have to deal, however, are that every substance in the universe possesses entropy to a greater or less and varying extent, that entropy is as much a common property of matter as density, resistance, temperature, volume, or pressure, and that we fail to note this property and its often significant change simply because we are unfamiliar with its manifestations and have no instruments for readily and accurately measuring it.

The exact physical significance of entropy is not, even now, fully understood. The favorite method of treating it, from an engineer's point of view, is to regard it as the weight of the heat. An analogue is drawn between the fall of water from one reservoir to another and the fall of heat from a higher to a lower temperature. The work done by the water is the weight of the water times the height of the fall. The work done by the heat is the entropy of the substance times the fall in temperature. Temperature is regarded as heat level, and entropy as heat weight, and the analogy is perfect for working conditions in the temperature-entropy analysis of steam engine efficiencies. It is apt, however, to lead to a confusing situation in the mind of the engineer, to be told that heat is energy, entropy is the weight of the heat or energy, and temperature is the level of the heat or energy.

A much clearer conception of entropy can be obtained from a study of the meaning of temperature, which enters into the definition of entropy. Temperature is known to be proportional to, and for all practical purposes can be taken as identical with, the mean kinetic energy of the molecules. The entropy therefore becomes the ratio between the heat or total energy in a substance and the kinetic energy in the substance. It may be a matter of surprise to most engineers that all the energy put into a body does not become apparent immediately in change of temperature, but this is seldom if ever true, even if change of state does not occur. Thus if the average kinetic energy of the molecules is increased 20 per cent, this means that the absolute temperature of the body is raised 20 per cent, but it may require an addition of at least several times this amount of energy to produce this change. The excess energy goes into the internal mechanism of the molecule, and is always a definite but varying amount of the whole. In the same way, if a molecule possessing 10 foot-pounds of kinetic energy, or energy of translation, hits the piston in the cylinder of a steam engine and rebounds possessing an energy of 9 foot-pounds, its absolute temperature fall would have been 10 per cent, but it may have given anywhere from 1 to 4 foot-pounds of kinetic energy to the piston. The reason for this is uncertain, but the fact is well known, and the factor by which the apparent transfer of energy in such a transformation must be multiplied to give the real amount of energy available, is called the entropy.

An analogy can best be obtained by considering a train in which the cars are connected by very powerful springs. The springs stretch in starting and a portion of the energy goes into them; the kinetic energy of the train is never the entire energy of the train, and under certain conditions the energy in the springs may become available as kinetic energy when the apparent kinetic energy of the train is changed. Entropy is a property of a body similar to this property of such a train. One can invariably obtain the work available by considering the fall in temperature, the entropy, and the amount of substance involved in the transformation. In this significance—namely, that of a multiplying factor—we may regard entropy, in a sense, as the weight of the energy. Not weight, as is ordinarily understood, but weight as assigned in giving proper importance to a given value.

With this conception of entropy, the entropy-temperature diagram of a steam engine acquires a much fuller significance. The temperature of a substance times its entropy is the total energy in the substance. Changes in either the temperature or the entropy mean change in the total energy of the substance. An isothermal change is represented by a line parallel to the temperature axis; an adiabatic, or an isentropic one, by a line parallel to the entropy axis. Carnot's cycle, consisting of two isothermal and two isentropic changes, is shown by a rectangle whose area is the work done during the change, as in the pressure-volume diagram, or indicator card. The work, however, is measured in heat units and must be multiplied by the mechanical equivalent of heat to transform it into the ordinary units.

Constant-pressure or constant-volume transformations of the working substance produce corresponding changes in the temperature and the entropy values of the substances, and the areas enclosed between the curves and the axes are equivalent to the same amount of work, measured, however, in different but convertible units. An entropy-temperature diagram of a steam engine shows in detail the exact values of the temperature and entropy of the working substances throughout the cycle and shows changes in heat energy during this time, thus telling the exact heat loss, or heat gain, in heat units, at various points in the cycle of the steam. Since the number of heat units in a substance depends on the quantity of the substances, it has been customary to consider the effect in a single pound of the working substance and consider its losses and gains in heat energy, from the boiler back to it.

We have come now to the practical development of entropy. Such a diagram shows absolutely losses or gains and their exact value in heat units, for superheating the steam, for steam jacketing the cylinder, for wire-drawing at valves, for quantity of moisture in the steam, and for initial condensation and re-evaporation of steam in cylinder. Changes in size of pipes, of valve openings, in size and shape of cylinder, in boiler capacities, in the initial and final temperature and pressure of the steam, in the various superheaters, and in the temperature of the condenser and feed water—all these produce changes in the form of the diagram, and the efficiency of each change can be readily shown at once and its value readily balanced against increased cost, without making the ordinary efficiency test for each change. The difficulty consists, however, in making this diagram. We have no instruments for measuring entropy directly. We must, therefore, measure the temperature of the substance at each point in the cycle and also the quantity of heat in it per unit—mass, and calculate the entropy from the definition. The quantity of heat may be measured by calorimetric methods, or it may be calculated if the mass, the specific heat, and the temperature are known. Steam always contains some moisture, and the specific heat of water is different from that of steam and in addition, there is an extra quantity of heat added to produce the change of state from water to steam. A throttling steam calorimeter may be used, however, to determine the percentage of moisture in the steam, and then the quantity of heat per pound of the mixture can be readily calculated. This must be done for every point in the cycle and it has been found easier to use another method.

Certain fundamental relations always hold between the pressure, volume, entropy, and temperature of a gas or working substance. By means of these, given the pressure and volume of the working substance, we can readily calculate its entropy and temperature. The pressure and volume can be readily obtained from an indicator card, and there exist a number of simple graphical methods for doing the computing and thus getting the entropy-temperature curve for the cycle. The volume obtained from the indicator is merely cylinder volume, not including clearance, and the ordinary indicator card must be modified, through a knowledge of the steam consumption of the engine and a pressure-volume steam table, to represent the volume of a pound of steam or working substance. The fact that engineers will go through these rather complicated operations to obtain a temperature-entropy diagram, speaks volumes for the usefulness and efficiency of this device. The invention of an instrument for the direct measurement of entropy would make its use in this connection almost as universal as that of the indicator for valve setting.

Although the application of the entropy-temperature diagram and the conception of entropy is valuable in steam-engine design, its importance is much greater in heat-motor work in general and in every heat-work transformation, wherever it may occur. In steam turbine construction it has become especially important, for the work done in this case is due directly to the kinetic energy of the molecules. The volume and pressure of the steam have not the same significance as in the ordinary engine, and the direct heat losses and gains due to change in temperature and entropy have a much greater influence in the transformation. The effect of change in the size and shape and angle of the vanes, the form and construction of the nozzle, the effect of superheaters and steam jackets, the initial and final temperatures and the humidity of the steam, and the strength of the vacuum in the condenser—all these can be most readily studied by this method and efficiency tests easily made, with a number of factors varying at the same time and each can be readily assigned its proper value. In addition, the mechanical end of the operation in this connection is not difficult. By means of a thermometer and throttling steam calorimeter inserted at regular intervals along the turbine, the temperature and humidity of the steam at these positions can be readily determined. By means of the humidity and the temperature, the heat energy in the steam can be readily calculated, and then the entropy, and the entropy-temperature diagram readily constructed. Slight changes in the working conditions will then produce changes in this curve which are readily identified and interpreted.

In gas-engine design and theory the conception of entropy and its utilization is equally important. The increased efficiency resulting from the use of high temperature is due as much to the fact that the entropy is greater at these higher temperatures as to the increased range in temperature available. In the choice and suitability of any working substance for heat-work transformations, the entropy is the important factor. It must be high in order that the product of it and the temperature, or the energy per unit substance, shall be high. The best working substance is the one that gives out the maximum energy per unit of the substance for a given fall in temperature. The variation in entropy with the temperature is also an important factor. A large change here with high initial entropy means especial suitability in a working substance for power production. At low coefficient of change with temperature combined with high initial entropy means special suitability for refrigeration. A special study of the entropy of steam and ammonia shows their remarkable qualities as working substances for their respective fields in comparison with other suggested materials. In refrigeration also, as can be imagined, the temperature-entropy analysis of working conditions is productive of remarkable results. Refrigeration deals principally with heat units, so the problem is simple in the system as a whole, but the same difficulties exist in the compressor as in the steam engine. In the construction of the compressor and of the entire refrigerating plant, valves, pipes, condensers, and coolers, the method can be used to advantage and the advantage of various changes is readily tested.

The compressor brings us to the subject of compressed air. This is a poor working substance from an entropy point of view, but it is doubtful, owing to its abundance, whether it will ever be displaced in its particular field of power transmission and energy reservoir. "Energy reservoir" may seem like a contradiction of the opening remark and needs a word of explanation. Compressed air is compressed adiabatically and then cooled off, and the process is sometimes repeated. All the work put into the air results in a rise in temperature, and this work is taken out in cooling it and lost into the atmosphere. In addition, a small extra amount of energy is taken in cooling, for the air finally arrives at a state equivalent to an isothermal compression, and an isothermal line is not as steep as an adiabatic, so the entropy of the air in the compressed state is less than in normal atmospheric conditions and there is really less energy in it, pound for pound. In expanding, the air cools off slightly, on account of a loss in its energy. This is resupplied by conduction from the heat in the atmosphere, and the process goes on until the pressures are equalized. Compressed air is in reality a converter of the energy in the atmosphere, and could not be used if this were shut off. It is analogous to a hole dug in the ground. The hole contains no energy, although energy was used in its construction. Energy can be obtained from it by letting water fall into it through a proper mechanism until it is full. Compressed air is in reality a hole in the entropy, and work is obtained by letting the entropy rise to the common level.

We have mentioned now all the immediate developments of entropy in the engineering field. In physics and chemistry, entropy is equally important. This is due to a general law that the entropy of the universe tends to rise to a maximum. It is related to the statement that the available energy of the universe tends to a minimum. By means of it many chemical reactions can be foretold and explained, and its influence in physical theory and research is much greater. The specialist in engineering physics can also in addition see many future developments for it in engineering fields not mentioned here and hitherto unapproached.

MINING METHODS FOR THE CULEBRA CUT.

By H. M. Chance.

Dr. Chance is so widely known as a sound and able mining engineer that he needs no introduction. The methods he suggests are not hypothetical; they are long proved by successful use. The proposal to apply them at Culebra, however, has elements of novelty and interest making this paper well worth considering. It may prove an important contribution to the solution of Canal problems.—The Editors.

NEARLY all writers who have discussed the proposed canal at Panama, recognize the time and expense required to remove the great mass of material at the Culebra Cut as one of the most serious objections to the adoption of a sea-level type, or of a lock-canal whose base is a few feet above high-tide.

As by reason of its magnitude the task is unique, it appears reasonable to look to methods heretofore unexploited, as well as to those in common use, to reduce this time and cost to within reasonable bounds. As it appears possible that the "milling system" of mining may prove applicable to this work, I propose to outline a plan embodying this system, by which this portion of the canal may possibly be finished in far less time and for many million dollars less than by the methods heretofore proposed.

Many individual scientists and engineers, as well as commissions and other bodies including eminent statesmen, civilians, and specialists, have reported upon the cost of construction and time necessary to complete a high-level lock canal, a low-level lock canal, and a sea-level canal across the Isthmus. Among the engineers identified with this work have been many prominent in civil, naval, and hydraulic engineering works, the personnel of these bodies, including the individual investigators and writers, embracing citizens of almost all civilized nations and representatives of almost every engineering art, except that of the mining engineer. As this work is essentially an open cut—a great hole to be dug through earth and rock—it is not surprising that the assistance of those skilled in excavating beneath the surface has not been utilized; but as the tricks of one trade are often useful in another, it may happen that the art of the miner can profitably be used in this undertaking.

Mining differs from most useful arts in that its functions are destructive rather than constructive, excepting such constructive work as may be auxiliary or preliminary to the destructive process.

In the extraction of ore and in the maintenance of plant deeply buried beneath the surface, the miner deals with transportation, drainage, lighting, and ventilation under conditions unknown in other branches of engineering. All these adjuncts to his work must be so installed as to be safe in the presence of strains and stresses of enormous proportions. The removal of coal or ore from a depth of 5,000 feet or more beneath the surface, the supporting of the overlying formation (whose weight evenly distributed produces a pressure of 5,000 pounds or more per square inch) while the mineral is being removed, and provision for its gradual settlement to a new bearing after the removal of the mineral without widespread disaster, is an example of the problems solved in underground work. The Culebra cut therefore presents no physical obstacles disturbing to the miner, the problems of excavation being interesting by reason of their magnitude, and as affording opportunity for the exercise of three fundamental arts in which the mining engineer is especially trained:—1. Economic and rapid excavation in rock. 2. Handling excavated material by gravity, rather than by manual or mechanical methods, 3. Transportation of large quantities of excavated material.

Neither the dredging of the canal through the soft alluvial deposits of the low-lands nor the excavation of the canal prism through the foot-hills where the rock cuts are of moderate depth, affords an opportunity for the exercise of mining skill; but the excavation of the Culebra cut, involving the removal of 100,000,000 or more cubic yards of rock and indurated clay before a sea-level (or low-level lock) canal is finished, being a task similar in many respects to the mining of great ore bodies, is one which the mining engineer should be qualified to discuss intelligently.

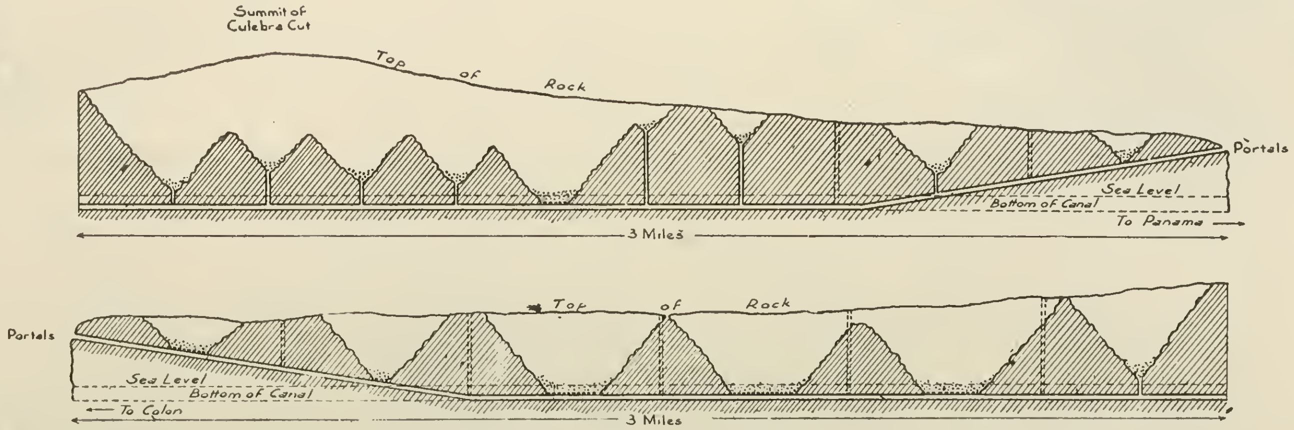
This mass of rock and indurated clay, averaging for a distance of nearly eight miles nearly two hundred, and for a short distance nearly three hundred feet in height (measured from the bottom of a sea-level canal), would naturally appeal to the miner as a gigantic ore deposit which must quickly and cheaply be mined. His first impulse, instinctively, would be to attack it from below—to get under it, and to utilize the force of gravity, rather than steam-shovels or other mechanical devices, for loading the broken rock; and his experience with the "milling system" of mining should enable him to plan for the efficient excavation, handling, and transportation of the material to be removed.

In carrying out this system, the first procedure would probably be to drive tunnels at the bottom level of the canal, deciding possibly upon four single-track horse-shoe tunnels, perhaps 15 feet in width and an equal height, so spaced as to cover the width of the canal at the base, and possibly 30 to 50 feet apart. These tunnels would extend the whole distance, six or eight miles, proposed to be excavated by this method, and at each end would rise by gradual gradients to the surface. They could be quickly driven by sinking shafts at frequent intervals (possibly one-quarter, one-third, or one-half mile apart) along their lines, and driving from the bottom of each shaft in both directions until the headings met. Tracks adapted to the heaviest traffic would be laid in these tunnels, and the shafts would be equipped with chutes and aprons for loading the broken rock into cars as they passed beneath. These shafts and tunnels should be completed in two years, at a cost of about $10,000,000, this expenditure providing handling and transportation facilities for moving 100,000,000 or more cubic yards, equal to a cost of about 10 cents for each cubic yard of total excavation removed through the operation of the system.

The tunnel transportation system, operated preferably by electric traction, might be so planned that in two of the tunnels the trains could pass constantly in one direction, while in the others the movement would be in an opposite direction. Each train upon emerging from any tunnel could be sent to the waste dumps, or to where the material was required for constructing embankments, and upon returning would pass through a tunnel in which the traffic was in the opposite direction from the one from which it came, again receiving its load in passing through this second tunnel and delivering it to waste dumps or embankments at the other end of the work, returning empty to the tunnel from which it first came. By this method of operation the waste material could be equally divided between the Colon and Panama ends; but if a larger proportion than one-half, or if all of the material, was required at either end, one of the tunnels could be used solely for the return of empty trains and the remaining tunnels for loading and transportation. By the use of properly constructed cars the trains could be loaded while moving at moderate speed.

When equipped with sufficient rolling stock, these tunnels should provide for the loading and transportation of 100,000 or more cubic yards of rock per day of two nine-hour shifts.

After the completion of the tunnels, the work of excavation would commence by converting the top of each shaft into a funnel, the excavated material filling the shaft and gradually being drawn out through the chutes into the cars in the tunnels below. As the



Diagrammatic profile showing method of excavating rock and its removal through tunnels. By H M Chance, Philadelphia, Pa.

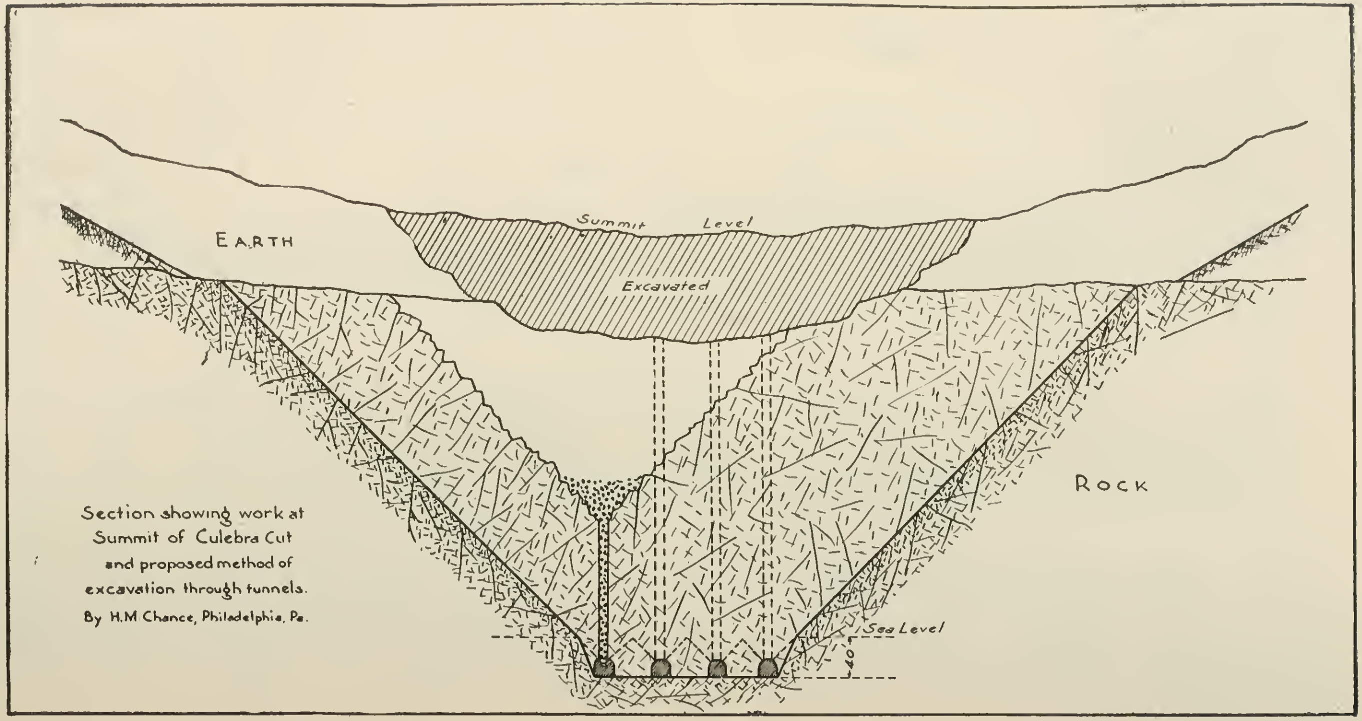
LONGITUDINAL SECTION (DIAGRAMMATIC) OF PROPOSED METHOD OF EXCAVATING THE CULEBRA CUT BY THE MILLING SYSTEM OF MINING, WITH TUNNEL TRANSPORTATION.

excavation proceeded, the site of each shaft would become a great conical or funnel-shaped quarry, the excavations finally reaching the top of the tunnel, and would thereafter progress in each direction as great quarry faces, with proper slope to permit all the excavated material to roll and slide down to the tunnel, there to be loaded through chutes as before described. Such portions of the top of the tunnel as were removed by this process would be covered by timbers upon which sufficient loose rock would always be kept to prevent damage by the falling of large rock masses.

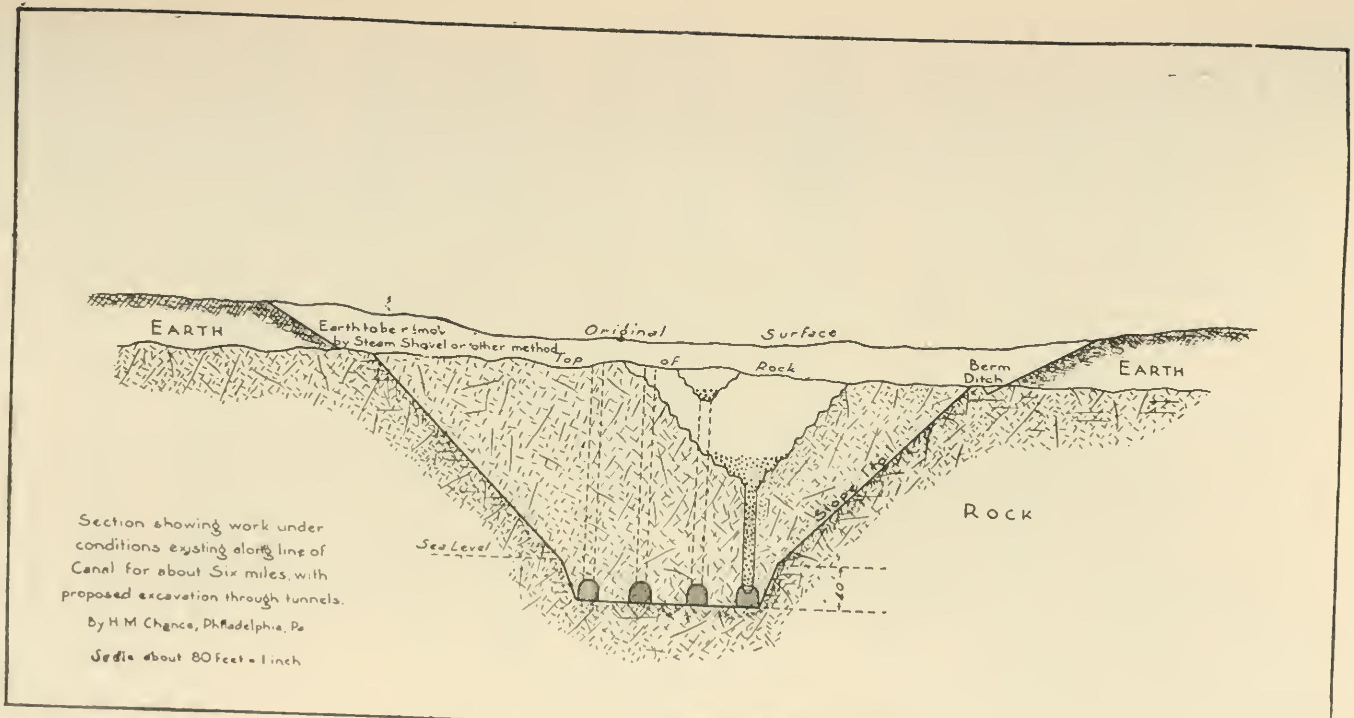
Viewed from an elevated point, the line of the canal would appear as a series of gigantic conical quarries, studded with rock drills busily at work, until having widened each excavation to the full width of the 45-degree or other side-slopes of the canal prism, the drills would continue excavating in line with the canal axis, gradually converting these conical quarries into oblong wedge-shaped cuts, until each meeting its neighbor and the barrier between removed, the canal prism would be complete excepting only the removal of the small pillars lying between the tunnels and above the tunnel roof.

Throughout the prosecution of this rock cutting, the visitor at the surface would see nothing but an array of rock drills, drill runners, helpers, and shot firers. No plant would be there excepting the drills and lines of pipe for steam or compressed air, and a series of light ropeways and derricks for handling the drills. As contrasted with the systems in common use, in which the excavated material is handled with steam-shovels, derricks, or mechanical conveyers, this method would eliminate the hundreds of steam-shovels with their thousands of attendants, the armies of track-layers and shifters, the hundreds of locomotives and miles upon miles of tracks, side-tracks, and switches, which must interminably be shifted and rebuilt, often with adverse grades, and which are more or less obstructed and perhaps damaged by every blast. With steam-shovels, cars, locomotives, and tracks, in addition to drilling apparatus, scattered throughout the work, blasting must always be cautiously done, with charges of moderate size; whereas the plan here proposed permits the use of as large charges of explosives as may be found most efficacious.

With a transportation system capable of loading and moving 100,000 or more cubic yards per day, the 100,000,000 cubic yards of excavation could be removed in between three and four years, for loading and transportation could proceed even in inclement weather, sufficient excavated material lying in the bottom of the quarries to



DIAGRAMMATIC CROSS SECTION SHOWING THE PROPOSED MILLING SYSTEM WITH TRANSPORTATION TUNNELS, FOR EXCAVATING THE CULEBRA CUT.


EARTH
Earth to be removed
by Steam Shovel or other method
Original
Surface
Top
of
Rock
Berm
Ditch
EARTH
ROCK
Slope 1 to 1
Sea Level
40
Section showing work under
conditions existing along line of
Canal for about Six miles, with
proposed excavation through tunnels.
By H M Chance, Philadelphia, Pa
Scale about 80 feet = 1 inch

THE SAME AS ABOVE, BUT SHOWING THE APPLICATION TO THE HEAVY CUTS APPROACHING THE CULEBRA SUMMIT.

To simplify these drawings, the shafts are shown located directly on the lines of the tunnels. A preferable method might be to locate them in the pillars between the tunnels, and connect them with the tunnels by inclined loading chutes.

keep the transportation system at work. Whether the rock could be excavated at equal rate is a very different question.

In the earlier stages of the work such rate of excavation probably could not be attained, and possibly during the first year the average rate could not be expected to exceed 20,000 to 40,000 cubic yards per day; during the second year, 60,000 to 100,000 cubic yards; and thereafter 100,000 or more cubic yards per day, requiring perhaps five years or more for the excavation of the whole prism. It is of course difficult if not impossible to predict in advance the rate at which this rock excavation can be performed, but there would seem to be small doubt that drilling and blasting could proceed far more rapidly under this method than when the work is obstructed by steam-shovels or other mechanical excavators, tracks, sidings, switches, cars, and locomotives.

The capacity of this tunnel method of excavating, loading, and transporting is so large that provision for prompt unloading becomes an important function, but efficient plans for disposing of the excavated material are essential to rapid construction irrespective of the methods employed in excavating and loading.

Computations may be made approximately showing the economy to be realized by replacing the steam-shovel or other mechanical methods by this tunnel method of excavation, and in making such estimates it is not necessary to deal with those items of cost which are common to both.

We may therefore compute this economy by adding to the cost of loading the broken rock by steam-shovel or other mechanical method, the wear and tear and depreciation in value of such machinery; the cost of laying, maintaining, and shifting car tracks, sidings, and switches; the cost of switching, car shifting, and transportation in the open-cuts, above the cost of car handling in tunnels; and the increased cost of explosives and drilling when using other methods, and deducting from this sum the first cost of tunnels.

Such computations indicate a net saving of not less than 25 cents per cubic yard—an aggregate net saving of $25,000,000, if the rock necessary to be removed be taken as 100,000,000 cubic yards, and a correspondingly larger amount should the material to be excavated exceed that quantity.

In the operation of this tunnel method of excavation, the installation of an automatic block system to control transportation, of telephones, safety apparatus, and chute mechanism to control the loading chutes, and of electric pumps and other devices common in mine and tunnel work, would form essential portions of the plant; and the construction and maintenance of pumps, auxiliary rock-chutes connecting with the main shafts and cuts to avoid removal of the whole tunnel roof, of shafts for exit and entrance and for air, of cross-cuts from tunnel to tunnel, and complete and efficient apparatus for ventilation and other minor appliances, would also be indispensable adjuncts which it is unnecessary to discuss in detail, the combined first cost of these adjuncts and their maintenance being apparently several million dollars less than the first cost and maintenance of the surface plant displaced or rendered unnecessary by the adoption of this method. Nor is it essential to discuss the devices and methods of operation to prevent blocking of the shafts and chutes by rock of large dimensions, nor for sustaining the weight of loose rock in shafts and chutes, as these difficulties have been overcome in operating mines by the "milling system;" my present object is merely to indicate briefly and clearly a general method by which it appears possible that the excavation of the Culebra or other similar excavations can quickly and cheaply be made.

The drawings illustrating this article are not intended to show a shape or form for the canal itself—which would probably be walled with nearly vertical walls and have a wide road-bed (tow-path) on both sides a few feet above the water-level, or be finished in accordance with such plan as those in charge of the work might deem most convenient or desirable—the sketches being mere diagrams made solely to illustrate the text of this article.

The "milling system" of mining is applicable only where the quantity of material to be removed is large. Few ore-bodies are of sufficient width and depth to permit its use, but under favorable conditions it is recognized as the cheapest known method for excavating and removing rock or earth. It has been profitably used on a large scale at the Treadwell gold mine in Alaska (where an open cut over 1,000 feet long by nearly 400 feet deep and 450 feet wide was taken out by this method) and at the Homestake gold mine in South Dakota, also in iron-ore mining on the Mesabi range, (where however the depth of the workings was not sufficient to realize the largest economy), also in a few instances in iron-ore mining in the Southern States, in gold mining in South Carolina and Georgia, in mining thick coal-beds in the anthracite coal-fields in Pennsylvania, and doubtless at many places at operations with which I am not familiar. There is therefore nothing new or experimental in these suggestions, excepting the proposed combination of a series of parallel tunnels and shafts with this "milling system" of mining to adapt it for use under the conditions present at the Culebra Cut.

EDITORIAL COMMENT

THE Senate, on June 21, passed the bill providing "That a lock canal be constructed across the Isthmus of Panama, . . . of the general type proposed by the minority of the Board of Consulting Engineers, created by order of the President, dated June 24, 1905. ." In an unexpectedly swift climax of victory, the lock plan has prevailed—the plan which, throughout, The Engineering Magazine has consistently advocated and urged. To this we have bent our best effort and energy, ever since the adoption of the Panama route ended finally our former fight against the Nicaragua project.

General Abbot's leading article in this issue, therefore, might appear to be a shot fired in signal or celebration of victory won, rather than one taking part in the fight. But though late in reaching the public ear, it was, in fact, one of the strong forces in the last great battle upon the floors of Congress. Advance copies, placed three weeks ago in the hands of the leaders of debate, played an effective part in the struggle. The General has helped once more in winning a triumph of no small significance and value to the country—a victory this time in the constructive arts of peace.

It is a most welcome pleasure to us thus to have rounded out and completed a record of ten years' service in the interest of "the best and most practicable route and plan for a ship canal across the Isthmus of Panama", as our judgment and our conscience directed.

This record, beginning with Mr. Going's disclosure of "The Absence of Facts about the Nicaragua Canal", in June, 1896, and now crowned by General Abbot's able and convincing reassurance as to the safety and merits of the lock-level projet on the Panama route, comprises a series of more than eighty contributed articles, reviews, and editorials, covering every phase of the question and pointing steadily to the conclusion now endorsed by both Federal legislative bodies. It is far too long a record for detailed review here, but some brilliant points may be profitably recalled. Early and significant among these stand the admirable series by W. Henry Hunter, chief engineer of the Manchester ship canal and late member of the Board of Consulting Engineers. His study of the economic influence of the ship canal, and his clear comparison of the Nicaragua and Panama propositions, did much to lay a strong foundation for sound public opinion on the questions at large. Next came the monograph by Charles Paine, past president of the American Society of Civil Engineers; his summary of the "Actual Condition of the Panama Canal", appearing in February, 1900, threw fresh and true light upon the status and value of the great undertaking which the French up to that time had been developing.

Our editorials on "The Unseemly Haste of the Nicaragua Advocates", and General Abbot's "International Aspects of the Panama Canal", with many other papers and discussions of collateral phases of the problem, carried on during the next two years the fight for careful study before decision. Again, editorially, in the summer of 1902, we urged most strongly the exercise of common-sense before taking any binding action upon vital points—the cause at this time being in particular the proposal to turn to Nicaragua on account of the unreasonable temper of a single official of the French company, and the sequence being the satisfactory acquirement by the United States of all the desired rights at Panama. Then, in 1902 and 1903, followed the notable debate in our pages between General Abbot and the late George S. Morison, bringing out the relative merits of several variants of the lock plan, and most particularly that of "the general type proposed by the minority of the Board of Consulting Engineers" and now accepted by the country.

This was followed closely by other contributions from General Abbot, widely recognized as the greatest living student of the problem of the Chagres:—"The Solution of the Panama Canal Problem" and "Conditions Affecting Building of the Panama Canal"; in sequence with these were contributed to our pages also important studies by members of the earlier Commissions—especially, Professor Burr's "Present Aspects of the Panama Canal Construction Work", and C. E. Grunsky's "Work of the Commission on the Panama Canal", (February, 1905), this latter being given to THE ENGINEERING MAGAZINE under the direct auspices of Admiral Walker, chief of the first commission charged with the construction of the great waterway. In this same number appeared our editorial upon "The Weight of Authority in Favor of the Summit-Level Type", which, followed and supplemented by further editorial comment throughout the past sixteen months, has made THE ENGINEERING MAGAZINE the leading advocate in the cause now so favorably decided.

Later, but by no means less significant, came the widely noticed series by John F. Wallace, late chief engineer. His articles, which ran from September, 1905, to March of this year, summed up the total experience of a man who had been for more than a year on the ground, in direct charge of the practical work, and face-to-face with "all the conditions there are." They made an able, honest, and fearless analysis of the dangers and defects of our National effort at constructive work, as well as pointed the way to the policy which would make certain its successful accomplishment.

It has been a long fight and a strong one—sometimes tinged with bitterness, but (with few and isolated exceptions) waged between honorable and conscientious champions on both sides. The great preliminary problems are settled, as we believe, soundly and wisely. The next question which must be answered, and answered rightly, if the work is to succeed, is that touching the mode of construction. In this it shall be our part to advocate, with all the earnestness and conviction we can command, the execution of the work by the contract system, in accordance with plans prepared and under supervision directed by the Government. Once more, as in the case of the choice of route and of the choice of general plan, it is to be anticipated that the first impulse of the public will be in opposition. Once more, we believe, honest study and clear statement of fact and experience, and fair deduction from precedent and example, will direct the enlightened common-sense of the people to the proper choice. In this, as in the questions already disposed of, we shall not fear to lead whither conscience and judgment direct, confident that the great body of our thinking countrymen will quickly hear, heed, and follow the same leading voices.

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We have referred more than once in these columns to the influence which the work of the engineer has had upon the solution of economic problems, and a very moderate degree of attention directed to this feature in modern industry will reveal innumerable examples of this relation. Thus, the modern tall building, itself as much an achievement of the engineer as of the architect or the business man, did not come into being until the development of the elevator made the use of upper floors a physical possibility. Even with the use of the hydraulic lift, buildings of more than eight or nine stories did not become general until the widespread introduction of the telephone made it practicable for a man to transact more business without leaving his desk than had formerly been possible by the combined use of the mail and his own legs.

It is a trite saying that railways have transformed commerce, but it is not so fully realized that with the improvement of communication in a thousand ways, by the telegraph, the telephone, the pneumatic tube, and even the mail chute, business has been facilitated, effort concentrated, and human energy conserved and directed.

Formerly a large element in commercial success was the ability to purchase a commodity in a place where it could be had cheaply with the opportunity of transporting it to a locality where it could be sold at a large advance, the profit depending largely upon the ignorance of the true value by the purchaser; but today the markets of the world are placed simultaneously before the purchaser and seller alike by reason of scientific methods of communication.

In like manner with the control and direction of human energy, the engineer is combining and controlling mechanical energy and directing natural forces. Already the development of the "white coal" of Italy, Switzerland, and France is diverting industry from centres originally created and still maintained by the diminishing supplies of fossil carbon. With the recognition of the fact that the true function of electricity is that of a transmitter of mechanical energy, there has come an industrial development which is necessarily causing economic methods to be profoundly modified. The possession of local power facilities, or of water-transport, no longer controls absolutely the situation of industrial establishments, any more than the position of tools in the shop is determined by the position of the line-shaft; the power is brought to the tool and, in many cases, the tool to the work.

In view of such developments it cannot be emphasized too strongly that the engineer himself should be a business man—that in all his work its influence upon business methods should be appreciated, and that his training should include such a broad appreciation of his relation to the work of the world as to cause him to realize his position as an economist. Even when the sad exigency of international dispute renders conflict inevitable, the engineer must fight the battles either afloat or ashore which determine the issue in question, and neither in peace nor in war can the nation which fails to use the services of the engineering profession hope for either temporary or enduring success.

* * *

It appears that the appropriation for the Geological Survey for the purpose of continuing and completing the testing of American fuels, and the extension of this work to the investigation of materials of construction, is in danger of being cut off. Since engineers and manufacturers in all parts of the country are strongly in favor of the continuance of this important work, it is to be hoped that they will strengthen the hands of those members of Congress who are endeavoring to have this appropriation restored, and use every means in their power to convince the committee of the great mistake which they are in danger of making. We have already expressed our own favorable opinion of this fundamental investigation, and trust that such a valuable series of original data will not be mutilated by being left in an incomplete condition.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

UNSOLVED PROBLEMS IN METALLURGY.

RELATIONS OF METALLURGICAL RESEARCH TO THE GENERAL DEVELOPMENT OF THE APPLIED SCIENCE OF ENGINEERING.

R. A. Hadfield—Institution of Civil Engineers.

EVERY department of engineering has its unsolved problems, but in view of recent developments it appears altogether probable that the work of the metallurgical engineer includes about as open a field for the ambitious investigator as could be desired. In the fourteenth James Forrest lecture, before the Institution of Civil Engineers, Mr. Robert A. Hadfield, known on both sides of the Atlantic as an earnest and successful student of metallurgical phenomena, discusses the problems immediately confronting the engineer, and his address is alike stimulating and encouraging.

Mr. Hadfield practically confines himself to that department of metallurgy with which his own name has been so closely associated for the past twenty years, the metallurgy of iron and steel, beginning with some statistical data to show the enormous magnitude of these industries.

"To give some idea of the gigantic nature of the operations of the metallurgist, and to show the enormous demand for iron, it may be mentioned that the estimated value of the world's products of iron and steel is now not far short of £1,000,000,000 annually The output of pig iron for 1905 was 53,000,000 tons, which is just double the production of 15 years ago, and of this probably 80 per cent is turned into steel. The total iron ore extracted yearly throughout the world is almost one hundred million tons. The pig iron production in the United States last year was 23,000 000 tons, or 4 000,000 tons beyond any previous record. Of this the state of Pennsylvania alone made nearly three-quarters of a million tons more than the whole of Great Britain.

"Notwithstanding the enormous strides made by other countries, the United Kingdom still holds the field in having produced the largest cumulative quantity of iron. We also yet export far more iron and steel than any other nation; twice as much as the United States, and nearly 50 per cent more than Germany. This is not a little remarkable in face of the statements made by some who are continually predicting our decline.

"Until recent times the manufacture of iron was carried on empirically, but since its production has been guided by the light of modern scientific knowledge the world's civilisation has progressed by leaps and bounds. Under the conditions of modern life the consumption of iron per head of population is an excellent index of the material prosperity of a nation. In America this has now reached the high figure of 619 pounds per head, as compared with 387 pounds in 1900, or 84 pounds in 1856, just half a century ago. The world's total production of pig iron in 1905 was 53½ million tons, representing an average consumption of about 68 pounds per head.

"It is unlikely there will be any halt in the enormous demand for iron. It is quite probable that by the end of the century, if the present ratio of increase continues, there will be a call for over 500 million tons of iron ore annually; for we must remember that, in addition to existing areas of consumption, Eastern nations will, without doubt, before long enormously add to their demands. This naturally raises the question—Will our sources of supply run short? It is a problem which time alone can determine. It can, however, almost with certainty be foreseen that the known iron ore fields of North America, Germany, and England will be exhausted within one or two centuries from now."

After discussing the properties of iron in its pure state, Mr. Hadfield shows the great extent to which these properties may be modified by special treatment. A fraction of one per cent of sulphur destroys the malleability when hot; the presence of carbon lowers the fusing point by several hundred degrees. Hardened carbon steel has ten times the hardness of the iron of which it is mainly composed; while the electrical resistivity is also increased tenfold by the addition of nickel and manganese.

"In its qualities under mechanical tests the changes are equally profound. Its elastic limit in the pure state is about 10 tons per square inch; this can be increased to over 100 tons in nickel-chromium steel. Similarly the tenacity, originally 19 tons per square inch, or even as low as five tons in cast iron, can be increased to 110 tons per square inch, or if wire-drawn material is considered, to over 200 tons per square inch. I have produced a nickel-carbon steel (carbon 0.41 per cent, nickel 20 per cent), not wire-drawn, which when tested in liquid air had a tenacity of 154 tons per square inch, with 15½ per cent elongation. The ductility or property of elongation of iron may be practically nil, or increased to over 70 per cent in the case of certain iron-nickel-manganese alloys. With such an extraordinary range of qualities it can, indeed, be said there is no other metal known which is so curious and at the same time so valuable to mankind."

All these remarkable variations in the properties of iron and its alloys are to be attributed to various forms of crystallisation and it is to the introduction of the microscopic study of the physical constitution of the iron alloys that our progress in their metallurgy is mainly due. In this connection the pioneer work of Dr. Sorby, as long ago as 1857, must be recognized, the development of these studies, in the hands of later workers, having been of the greatest importance.

The whole art of producing steel of high quality consists in obtaining and controlling the type of crystallisation desired.

One of the most important factors is that of temperature, but until comparatively recently there were no means of checking this; we had to depend on the eye alone. This human instrument was too uncertain, except when working with special brands of steel, such as tool steels, these usually being bars of small dimensions, and dealt with in the smith shop. Many irregularities arose in the early studies of special alloy steels, and without our present knowledge of their heat treatment, and consequent control of crystallisation, these alloys would be practically useless.

Mr. Hadfield discusses the important influence of heat treatment upon steel, and the consequent value of modern pyrometers in enabling the accurate determination of high temperatures. The metallurgist of today must also be a physicist, skilled in the use of instruments of precise measurement, including the extension of their applications far beyond the limitations of the physical laboratory.

"There are many unsolved problems to be worked out in connection with the production of steel. The Bessemer and Siemens-Martin processes have been carried to a great refinement, and the material produced by them, as regards quality, holds a high place in engineering construction, whilst the rapidity of production and low cost they have made possible are economic advantages of a high order. Beyond improvements in detail, none the less important because they are small, these processes remain in principle much as they were originally. It will probably be a long time before they are supplanted.

"There are those who look forward to an electrical method of producing iron and steel. If any practical system of this nature for converting iron ore into pig iron or steel could be introduced, using the stored-up powers of Nature instead of burning carbonaceous fuel, the revolution in practice would be great. Probably over 100 million tons of coal, equal to about one seventh of the world's total output, are used annually in the smelting of iron, to say nothing of the further large quantities employed in the subsequent working of iron and steel into more finished form. Where water power and suitable iron ore can be found together, then, no doubt, satisfactory electrical smelting practice will be developed, but this can only come slowly.

"Pioneer work is being done in Sweden, France, and Canada, in electrical smelting for the production of steel, but unless water-power can be obtained at economical rates it would seem that the application of this system must remain very limited; that other sources of power should be used at present appears out of the question from an economical point of view. Moreover, the electric furnace does not purify steel more than other furnaces not specially adapted to that purpose. Bad steel can be produced by it as easily as by the ordinary processes. Some of us know how often the old type of crucible steel smelting, so largely practised in Sheffield, has been threatened with extermination, but more material is now produced in this way than ever before. The electrical system has in this older method, notwithstanding its extraordinary wastefulness, a competitor that will not soon be annihilated. There is no magic in the electrical method as it would seem some would have us believe. Steel made by it shows similar analysis, and has the same physical qualities as that produced in other ways."

Mr. Hadfield naturally refers to the alloys of iron and manganese with which his name has been so closely identified, and this alloy seems destined to create some remarkable results in the modification of materials of construction.

"In the brittle iron-manganese alloy containing 4½ per cent manganese, the properties of iron seem quite reversed. Although the carbon present is comparatively low, yet this alloy is more brittle than cast iron. With an increase of manganese to about 12 per cent the properties of this alloy again entirely change, and it becomes of more than ordinary interest. When forged and treated, this steel has a tenacity of about 60 tons per square inch, with a ductility of 40 per cent to 50 per cent, or considerably more than that of pure iron. Yet the determining factor, manganese, is in itself an exceedingly brittle metal. It also becomes practically non-magnetic, and, unlike certain nickel-iron alloys which also appear to be non-magnetic, but are reversible, it cannot be rendered magnetic even by quenching in liquid air, nor does ordinary heating render it magnetic. When it is considered that the same metal, manganese, combined with copper and aluminium in the material known as the 'Heusler' alloy, gives a magnetic product, although no iron is present, it will be recognized what a wonderfully wide field for research is offered by alloys of various kinds. The results to be expected are so curious that it is not possible to generalise from one to another; each alloy must be worked out."

The constructing engineer is naturally interested in the actual properties of his materials of construction, apart from the method by which those properties are obtained, and this leads directly to the broad field of the testing of materials.

"We here enter upon a domain in which the civil engineer is largely interested. Whilst he may not in a direct form concern himself so much about the manner in which the material brought to him by the metallurgist is produced, he now takes great interest in its properties. He inquires how it will stand in every-day service under shock, wear and tear, atmospheric influence, and other conditions to which it may be subjected. He properly says: 'These wonderful tests are very well, but can you always produce them regularly? Is the material economical in practical use?' He also asks other questions of a like nature. He must not be too exacting, however, for a friendly word of encouragement from the user to the metallurgist has the greatest influence in spurring him on to meet the increased severity demanded by modern conditions, even if he at first fails. Bessemer's first rails were laughed at, and yet today statistics tell us there are 525,000 miles of single track of railway in the world, or a total length of considerably over 1,000,000 miles of rails. This means there is a total of about 71,676,000 tons of rails in use at the present time, most of them made by Bessemer process."

TEMPERATURE CONDITIONS IN UNDERGROUND RAILWAYS.

EXPERIENCES WITH THE DEVELOPMENT OF HEAT IN THE OPERATION OF ELECTRIC RAILWAYS IN CITY TUNNELS.

H. Kayser—Gesundheits Ingenieur.

IT is always well to endeavor to profit by the mistakes of predecessors, and it is interesting to note that in Germany the question of proper ventilation and cooling is being considered in connection with proposed tunnel railways, in view of the somewhat unexpected results which have developed in the New York subway and the Paris Metropolitan. In an article by Inspector H. Kayser, in a recent issue of the *Gesundheits Ingenieur* the whole subject is discussed in the light of American and European experiences, with suggestions for the abatement of the heat-difficulty in connection with proposed structures in Berlin.

There has existed a very general popular opinion that underground electric railways would be accompanied with a greater degree of uniformity in temperature than existed on the surface, being cooler in summer, and not so cold in winter, this opinion being doubtless derived from the conditions existing in cellars and underground basements of buildings. Practical experience, however, showed the fallacy of this opinion, since, in the heated summer weather in New York it appeared that the temperature in the subway was from 3.3 to 4.4 degrees centigrade higher than that of the outside atmosphere, and that similar results were experienced in Paris.

This apparently unexpected result is simply explained by the fact that a large part of the electric energy delivered to the motors on the trains is converted into heat. Not only the losses in the conversion, but all of the energy suppressed in bringing the trains to rest, is converted into heat, and unless some method is introduced for its dissipation it not only appears as heat but the heat is allowed to accumulate until the temperature is raised to a degree too high for comfort. This is true not only of the electrical energy but of all the other forms of energy which are changed by the propulsion of trains through a tunnel against various resistances. Thus the rail friction, the atmospheric resistance, the brake friction, and every form of absorption of energy not otherwise accounted for must reappear as heat, and, in the absence of any special methods of dissipation can only, appear in the increased temperature of the contained mass of air.

The facts in such cases may be made to appear in a more concrete manner by the presentation of the subject in the way used by Inspector Kayser to give the natural result of the operative conditions. If, for example, the power house by which the electrical energy is furnished, consumes 500 tons of coal per day, and if only 10 per cent of this energy reappears as heat through unavoidable losses in the tunnel, the heating effect will be the same as that which would be produced by the combustion of 50 tons of coal per day in the tunnel, and devoted to the warming of the contained mass of air.

Inspector Kayser examines the computations which have appeared in some of the American technical journals regarding the actual amount of heat evolved in the New York subway, showing that this action is amply able to account for the difference in temperature between the air in the tunnel and that of the outside atmosphere, and he shows that the conditions in Paris confirm the results developed in New York.

Since the rate of dissipation of heat in a tunnel has an important bearing upon the rate at which the temperature of the contained air increases, Inspector Kayser considers that nature of the soil through which the tunnel passes as an element in the problem. The subway in New York passes through a body of sand and rock which forms a very effective non-conducting jacket to the tunnel, so that the conduction of heat through the walls is comparatively slight, and hence the only way in which the excess of heat can be effectively removed is by convection with the movement of the air. In this connection the experience with the underground portion of the Berlin municipal railway extending to Charlottenburg is cited, showing, in winter weather, an increase of 4 to 5 degrees centigrade above that of the external air, while the surrounding earth showed a still higher temperature.

There appears to be no doubt that it is by a continual change of air that the heat is to be carried away from any such underground railway, and hence it should be a part of the original design of such a subway to provide for a determinate movement of the contained air by some artificial and controllable means.

Air which is intended to serve as a cooling medium should contain a proper amount of moisture, since this adds very greatly to its capacity for absorbing heat. Thus the evaporation of one cubic metre of water involves the absorption of 560,000 calories, an amount estimated equal to 10 per cent of the entire heat developed in the Berlin subway, and there appears to be no difficulty whatever in the evaporation of a cubic metre of water over a length of four kilometres. The absorption of such an amount of water need not render the air uncomfortably moist, since the movement of the air required for ventilation would effect a change with sufficient rapidity to keep the atmosphere from approaching such a degree of saturation to produce discomfort. When a tunnel is driven through moist earth it is advisable to permit this ground water to maintain the interior of the tunnel in a moist condition, this providing an absorbent for a large portion of the heat.

The movement of the air in tube tunnels is largely effected by the motion of the trains, the cars so nearly filling the section of the tubes as to act almost like pistons. For tunnels of larger section, admitting two or four tracks, this action cannot be relied on, and some auxiliary system should be employed. Where the tunnel is nearly level, probably the circulation of air will require the use of fans of other mechanical appliances, but if the road includes ascending and descending grades it will be found possible to place ventilating shafts at the highest and lowest points, the warm air ascending through the highest shafts will produce down currents through the shorter ones and thus maintain a circulation without the use of any machinery.

It is interesting to note in this connection that in the New York subway a plan is being installed which includes the mechanical exhaustion of air from points between the stations, while openings near the stations are made to provide for the inflow of fresh air, a very obvious improvement and one which might well be incorporated with any tunnel of later construction.

THE EDUCATION OF ENGINEERS.

REPORT OF THE SPECIAL COMMITTEE APPOINTED TO DISCUSS THE BEST METHOD OF PRACTICAL AND SCIENTIFIC TRAINING FOR ENGINEERS.

Institution of Civil Engineers.

FOR nearly three years there has been in session a committee of the Institution of Civil Engineers, including among its members some of the most eminent engineers in the United Kingdom, discussing the best methods of training for all classes of engineers, the scope of this inquiry including both scholastic and subsequent education. The instructions given to this committee stated that the principle that the education of an engineer should include both practical experience and scientific training, should be maintained. This committee has now made its report, and in view of the eminence of its members, and the length of time during which the subject has been under discussion, the report is certainly entitled to most respectful consideration. With a broad catholicity, which might well be imitated by professional organisations in other parts of the world, the Council of the Institution requested the co-operation of a number of other engineering societies, and the constitution of the committee includes representatives of practically all the co-ordinate branches of the profession. The scope of the work of the committee included preparatory education in preparatory schools; training in offices, workshops, factories, and on works; training in universities and higher technical institutions; and post-graduate work. A vast amount of correspondence and preparatory work was carried on, and in this respect the committee appears to have been especially fortunate in receiving an unusually large proportion of replies to its inquiries.

So far as preparatory education is concerned, the recommendations of the committee appear to be almost revolutionary in their character. It is considered that the students should be taught something about English literature; that Greek should not be required, but that a colloquial knowledge of French and German should be acquired and that mathematics should be regarded as something more than an intellectual exercise! When to these remarkable attainments it is added that some knowledge of elementary chemistry and physics is considered, even if known under its ancient appellation of "natural philosophy," it will be realised that the committee has already been aroused and possibly that its efforts may succeed in awakening some other educators in the United Kingdom. The committee believes, and in this there are few, we imagine, who will differ from them, that students who enter technical institutions are ill-prepared, and that it is most important that the preparatory educational schools should do their work more intelligently, and thus relieve the technical schools from a heavy handicap. It does not seem to have occurred to the committee that this result would be attained simply by making the entrance conditions of the technical schools more rigid, and thus enable the same weeding-out process to be effected in Great Britain as has long ago been accomplished in other parts of the world.

There has naturally been attention given to the incubus of "established customs," and the report has had to be guided in many respects by the burden of methods inherited from earlier times. It does not seem to be realised that the profession of engineer is similar to the profession of lawyer, or physician, but rather that the engineer is what has been termed a sort of "sublimated tinker," and that, as such, he should be sent to the workshop for a year of two before he is allowed to enter the university, just to show him that he is nothing but a workman after all, and that by and by, if he is real good, he may be allowed to learn something more.

Great Britain has evidently something yet to learn from the nations with which she has to compete, and to realize that the highest kind of scientific training is none too good for the men who are to do the things which are necessary to maintain her supremacy in the conduct of the affairs of the world. In other lands young men are trained in the preparatory schools in such a manner as to render them fully eligible to enter the universities immediately in grades fully equal to those held by other professional courses. The universities regard them, socially and technically, as the peers of students in every other department, and upon the completion of their courses these graduates are snapped up by the greatest manufacturing establishments in the world, before they have even had time to receive their degrees.

With such precedents before them it certainly does seem as if the committee of the Institution of Civil Engineers and other engineering associations might have looked beyond the encircling seas and endeavored to meet the competition of other lands, or even of the colonies of their own imperial realm. The world moves, and methods of education suited to present-day needs must not be hampered with the mediæval precedents of educational institutions of the past. The student of today should have to ask favors of no one, he should be able to make his own way with the training which he acquired by his own hard work. Manufacturing establishments, instead of demanding premiums from him for the privilege of entrance into their sacred precincts, should offer him living wages from the start, and understand that they are conferring no favors, but receiving full value therefor. The old apprenticeship idea is based upon the theory that the man in the shop knows it all, and that, by attrition and hard knocks, the apprentice may ultimately absorb some of his wisdom, while, as a matter of fact, the old-time machinist is as often as not a venerable moss-back, knowing little and caring less about the real progress of the shop in which he works, and bent upon maintaining the obsolete ways which he himself learned from his fathers.

The whole tendency of modern workshop methods is to get rid of the hand worker as much as possible, to provide modern, scientifically trained experts to keep automatic machines in operation with ordinary laboring service to the greatest possible extent; the shape of tool, the form of cut, speed, time, and all the rest, having been predetermined independently of the man who attends the machine. The scientific engineer who spends time in the shop learning such details is almost certain to find the whole scheme altered before he has an opportunity of putting his shop experience into practice, and in any case he is more than likely to be the one himself to apply the principles which he has acquired to the improvement of the method in the shop. In the cabinet of curiosities of one of the engineering associations there is preserved a hand tool once used by an eminent engineer, still honored on both sides of the Atlantic as the dean of his profession. Whatever skill may have been attained in the use of this clumsy combination of wood and steel is also relegated to the limbo of the past, and so in like manner, only far more rapidly, must go the individual shop methods of the journeyman mechanic of today.

One of the real difficulties, and one which is not touched upon in the report of the committee, is the lack of real practical men among the instructors and professors by whom the student must be taught. Too often the professor himself has never really been outside of the class room, having become an instructor upon his own graduation, and thence risen to the professorial chair without ever having had a chance of seeing how things are actually done in the workshop outside.

Post-graduate work receives notice in the report of the committee, coupled with the statement that the number of post-graduate students is not likely to be large at any time. If the original educational work has been properly conducted the whole subsequent career of every student should constitute post-graduate work of the highest order, and it is by the results of this true post-graduate work that the merits of any system of education are to be judged.

In its closing paragraph the committee refers to the "sympathetic" assistance of employers as essential to improvement in engineering education and training. Any system which depends upon the "sympathetic assistance" of the employer is likely to wait a long time for help and encouragement. Mr. Andrew Carnegie tells of the time when his firm was induced to employ a German chemist who wore spectacles, and also relates how this same spectacled chemist soon showed them how they were wasting many thousands in their ignorance of the qualities of the materials which they were buying and selling. The "sympathetic employer" needs to be shown that it is money in his pocket to employ the technically trained student, and as soon as that fact is realised there will be no further need for plans for technical education to be formulated, the demand will create its own supply of properly trained men, and the employers themselves will endow the educational institutions in Great Britain as they have done in other lands.

THEORY AND PRACTICE IN MACHINE DESIGN.

APPLICATIONS OF THE PRINCIPLES OF THEORETICAL MECHANICS TO PRACTICAL MACHINE DESIGN.

H. Lorenz—Verein Deutscher Ingenieure.

IT is not so very long ago that the idea of the so-called opposition between theory and practice was generally accepted, and the practical man was held by the general observer to be the man who really did things, while the theoretical student was generally considered as a visionary and unpractical individual. That this view of things has been replaced by one which accepts the union of both theory and practice as especially valuable, is now well known, and indeed it is largely because of the acceptance of methods indicated by students of theory and its application to practical work that the great industries of the world have grown to their present enormous importance. In an address delivered recently before the *Verein*

Deutscher Ingenieure, and published in the *Zeitschrift* of the society. Professor Lorenz discusses the relation which the application of theoretical mechanical principles bears to the development of modern machine design, and cites some important results which have followed from the union of the two elements, formerly considered as non-related, if not antagonistic.

Dr. Lorenz calls attention to the important influence which the mechanical laboratory has had upon the application of scientific principles to practical work. During the past fifteen or twenty years, both in Europe and America, the mechanical laboratory has become an accepted part of the training material in the university and high school. The student has by this means had opportunity of seeing the meaning of many things which otherwise made but a faint or fleeting impression upon his mind. Mathematics, from being a training for the mind as a sort of intellectual gymnastics, became a working instrument, not greatly different from the tools in the shop, while the certainty that theoretical deductions were to be put to the stern test of actual trial brought with it an honesty of work and purpose not formerly attainable. The laboratory was therefore a means for the development of both the teacher and the pupil, and in the opinion of Dr. Lorenz, this phase of technical instruction has had much to do with the development of applied science.

One of the departments of theoretical mechanics which has had an important influence upon the development of applied science is that relating to the study of vibrations. This fertile field of scientific study relates to all phenomena which have a well defined periodicity, and which return upon themselves at regular intervals of time. One of the simplest examples of this form of motion is that of the swing, well-known to children, but hardly considered as an example of an important mechanical illustration. The pendulum, however, from the time of Galileo onward, has been a marked instance of the application of mathematics to mechanics, and since the time of Watt the circular pendulum has been the basis of nearly every form of speed regulator in practical use. Following the study of oscillations still further we reach the broad subject of alternating electrical currents, which play a most important part in the transformation and long-distance transmission of energy in the form of electricity, and which have enabled mathematical research to be applied in a wide sense to mechanical problems of a most practical nature.

The mathematical study of mechanical problems has enabled the engineer to solve some important questions relating to disturbing vibrations in machinery. Thus, the action of reciprocating masses in high-speed steam engines has been studied with excellent results. Dr. Lorenz gives much credit to Radinger for his complete analysis of this problem in his important work, published first in 1870 and recently in a newer edition, but it must not be forgotten that this whole question was entirely solved by Mr. Charles T. Porter in connection with the design of the Porter-Allen engine, which was exhibited in complete running condition at the Paris exposition of 1867. The principles of the proportion of reciprocating parts in high-speed machinery now constitute a definitely solved problem, and one which could only have been settled by the application of the principles of mechanical theory to an important department of machine design.

With the application of multiple-expansion engines to marine propulsion and with the increase in the dimension of steamships came the question of the balancing of the engines so as to avoid the vibration of the hulls which had been growing objectionable and even injurious. A study of the theory of vibrations showed that the hulls of large vessels had well-defined periods of vibration and that if suitable multiples or divisions of these rates of vibration were produced by the engines a cumulative effect might be produced which was at least unpleasant, and at most might be disastrous. By the application of the theory of vibrations to the conditions of operation the remedy became apparent, and today engines with multiple cranks have their crank angles so arranged that the various forces oppose each other in such a manner as to reduce vibration to a minimum, while the period of the propellers and the hull are so chosen as to render cumulative effects a minimum as well. Professor Lorenz naturally desires to secure as much credit and honor to German engineers, as possible, and we are far from wishing to diminish any portion of the honor belonging to the profession in Germany for the application of theoretical principles to practical work. Herr Schlick deserves great credit for the important work which he has done in applying the correct principles of mechanical science to balancing of marine engines, and we are especially glad to perceive that Dr. Lorenz gives proper credit also to the American naval constructor, Mr. D. W. Taylor, for his pathmaking work in this same department of applied science.

This important question of oscillations extends into nearly every field of applied science. Dr. Lorenz shows how it affects the resistance of beams, the torsional resistance of shafting, and the whole scope of resistance of structural combinations in a way which can be studied only by the engineer who is familiar with the correct theory of mechanical action. Any so-called practical solution of such problems can be but empirical at best, and there is no way in which practical experience gained from one case can be extended to subsequent examples, while with the application of theory to actual examples general laws may be deduced for subsequent use in connection with similar work.

The use of the steam engine indicator is one of the oldest applications of scientific theory to actual practice, and this instrument itself has of late been subjected to scientific analysis, as its applications have become extended. The inertia of rapidly moving masses becomes an element of importance with high-speed motors, besides which questions of temperature and elasticity have to be considered.

In the domain of hydrodynamics the applications of theory to practice have become of increasing importance. Thus the laws governing the efflux of liquids from orifices have been made the subject of scientific investigation, while the contraction of the liquid vein has shown itself amenable to mathematical analysis. The increasing importance of turbine water wheels, in connection with the utilisation of natural sources of water power have led to scientific studies of the principles of such motors, with the result of increasing the practical efficiency of such machines.

Another department of applied science in which excellent results have been secured is that relating to the laws of friction.

The investigation of Lasche have shown the important influence which is exercised by temperature upon the coefficients of friction and the action of lubricants, while the researches of Stribeck have placed the subject of ball and roller bearings upon a scientific as well as a practical basis.

These are but a few of the instances which might be cited to show the close relation which now exists between theory and practice, and which demonstrate that the profession of engineering is rightly claimed to be the profession of applied science.

EXPLOSIONS IN MINES.

PRECAUTIONS AGAINST EXPLOSIONS OF DUST AND FIREDAMP IN THE CONDUCT OF AMERICAN COAL MINES.

J. T. Beard—Engineering and Mining Journal.

LAST month we reviewed in these pages a paper relating to the prevention of explosions in mines, based upon practice on the continent of Europe, showing what had been done and what might be accomplished to increase the safety of colliery workers. In a recent issue of the *Engineering and Mining Journal* there appears a paper by Mr. J. T. Beard, discussing similar conditions in the United States, this supplementing very acceptably the paper by M. Schmerber reviewed last month from the pages of *Le Génie Civil*

"There is perhaps, at the present time, no subject relating to the protection of human life that demands the prompt, thoughtful and intelligent consideration that is daily being asked in behalf of mining. The importance of this great industry is acknowledged on every hand, but the increasing dangers of the work are not as generally comprehended or recognized. Even those most familiar with mining conditions often manifest a disinclination to regard those conditions seriously, and every day the reckless miner is permitted to engage in practices known and admitted to incur great risks, from which all men would shink if contemplated in another atmosphere than that of the mine. This may be in part the result of ignorance, in many cases it is; but there is beside, a less responsible element in the make-up of the average mining man, an element for which there is no reasonable excuse, as there may be for some cases of ignorance."

After discussing the dangers which arise from falling roof and coal, Mr. Beard shows that while about 50 per cent of the accidents are due to this cause it is the other half, being those due to explosions of dust and gas, which can be made best subject to control and regulation. In this respect conditions in America are still behind those in Europe, and the new country has much to learn from the old.

" Mining in the United States, though not as old as in England and on the Continet, has still reached a stage where more coal is produced each year than in any other country. We cannot afford, therefore, to disregard longer the necessity that compels us, as other countries have done 25 years before, to do everything possible to safeguard an industry that measures the peace and prosperity of the country. No one can study the work and findings of the French Firedamp Commission, 1882; the Prussian Firedamp Commission, 1885; the Austrian Commission, the same year; the English Accidents in Mines Commission, 1886; and the Royal Coal Dust Commission of England, 1891, without being deeply impressed with the efforts these countries have made in this direction and the great good accomplished. Under our own Federal Government many of the States have acted on their own recognizance and appointed commissioners for the purpose of investigating local mining conditions relating to this class of accidents. Such were the Iowa Commission, 1902; and the Kansas Commission, 1905."

The earlier disasters in coal mines in all parts of the world were largely due to the ignition of gas by the open lights generally employed, and although the so-called "steel mill" of Spedding was devised as long ago as the early part of the eighteenth century, it was by no means as safe as was at first supposed, the inventor himself losing his life by an explosion of gas in his own colliery. It was not until the invention of the modern safety lamp in 1815, that it really became possible to employ a flame with any degree of safety in the presence of mine gases.

" A new era in the mining of coal at once began, but as great a boon as the safety lamp has ever proved to be, it could not wholly prevent the occurrence of explosions, which is chiefly due to the misuse of the lamp through ignorance on the part on the miner. Many miners today who use safeties betray ignorance or disregard or both, of their proper use. One of the first principles to be learned by one who is to use this lamp is that it is very unsafe when improperly used. One of the greatest evils in mining today and one which is probably responsible for many disasters and much loss of life is the official sanction of the use of mixed lights. If safety lamps are at all necessary in a mine chamber, they are liable to be required at the moment when the miner is most absorbed and least suspects his danger. One might as truly expect a child to escape unharmed if allowed to play with dynamite as to expect the ordinary miner to avoid accident when permitted to use an open light in a chamber or heading known to be generating gas. For the safety of men and the security of property this statement should be made even stronger: Where safeties are required in any section of a mine, an open light should not be allowed in that section, and if open lights are in use in other sections of the same mine, the roads leading to the affected district should be guarded by a responsible person to prevent any one entering the same with an open light. The point to be emphasized here is that mine regulation should absolutely prohibit the use of mixed lights, under any conditions whatever. This rule should be inexorable, and the penalty for its infringement should be severe. It is time that we arouse to the necessity of safeguarding this condition by some other means than leaving the question of the use of open lights to be determined indiscriminately by the judgment of the miner, or by the willingness of any official to allow a heedless miner to assume risks that reason condemns."

After referring to the recent disaster at Courrières, Mr. Beard discusses the explosion which occurred at Fernie, in British Columbia, in 1902, and then proceeds to compare the effects of gas and dust explosions, showing that in the case of gas the force is concentrated at the initial point of ignition, while with dust the combustion advances, feeding on the intake air.

The force developed bv an explosion is enormous. Mr. Beard computes, from the chemical reactions, the amount of heat liberated by the combustion of dust and of firedamp, showing that a pound of dust produces nearly 5,000 foot-tons by explosive combustion, while a pound of methane produces more than 9,000 foot-tons.

The meaning of these figures may be grasped better when it is understood that a pound of gunpowder develops about 500 foot-tons, and a pound of nitro-glycerine about 1,100 foot-tons.

"In considering a mine explosion there is a general willingness, not to say tendency, to consider the gaseous condition of the workings in any given case as varying only with the physical conditions in the mine, by which is meant those conditions relating to the number of feeders active, extent of faults, area of abandoned workings, standing, frequency of roof falls, etc. Sufficient attention has not been given to the variation of pressure of gas that may occur at irregular intervals in the strata. This variation of pressure has its origin within the earth and results in a more or less spasmodic outflow or emisison of gas from the strata, which may be approximately called 'earth breathings.' The direct result of irregular earth breathings is a corresponding fluctuation in the gaseous condition of all underground workings. This theory if true, would give rise to periods of frequency of mine explosions, assuming an increased outflow of gas brings an increased liability of explosion. It is clear, however that explosions may occur at times when the outflow of gas is less, and may not occur in the proper periods when the outflow is stronger, but these would not necessarily argue against the theory of periods of danger. At the most such errant explosions would only prove that periods of danger in mines are not always periods of frequency of mine explosions."

CENTRAL-STATION ECONOMY.

THE INFLUENCE OF THE DEVELOPMENT OF THE DAY LOAD UPON THE ECONOMY OF CENTRAL ELECTRIC POWER STATIONS.

Iowa Electrical Association.

WHEN electricity was first introduced as a commercial undertaking the lighting business claimed first attention. This naturally meant a load which was practically nothing during the day time and which reached a maximum some time during the evening. With the development of electric power it appeared that it was possible to build up a day load which might supplement the electric lighting demands of the evening, and thus enable the plant to secure paying business during the twenty-four hours. This subject has been developed to a marked degree at the present time, and in the large cities there is ample demand for current for all purposes at all hours. In the smaller towns the day business has to be built up, and the desirability of doing this formed the subject of an interesting symposium at a recent convention of the Iowa Electrical Association. In discussing the subject Mr. C. H. Walsh of Burlington, Iowa, gives an excellent presentation of the conditions under which such a plant must be operated.

"In the design of a central station plant, the one great aim is to attain the highest possible economy in the operation of all departments of that plant

"Boilers, engines, dynamos and distributing systems are so installed, that the maximum assumed load may be carried in an economical way. Economy means not only the saving of so much coal and water, but also the application of the energy derived from these requisites in such a way that the greatest money returns may be obtained from them. Many plants, built originally, perhaps, for street-lighting purposes, or for commercial service from dark to daylight, have extended their scope of operations, adding other departments still, and increasing their revenue. The same is true of plants in the larger cities, where, although twenty-four hour service was given, the night lighting load was originally the principal source of revenue.

"The purpose of day load is, naturally, to be able to use apparatus installed to meet peak conditions, at times when the load curve approaches the minimum, making this curve come as nearly as possible to the straight line for the twenty-four hours, and making the machinery help pay fixed charges on the plant, at times where otherwise it would be idle. These fixed charges will naturally be increased to some extent by the addition of the necessary apparatus and means of distributing day load, and the extra labor necessary to handle it will need to be considered, still it is a fact that these items are but a small proportion, ordinarily, of the possible increase in revenue.

"Day load may be added in a variety of ways and each class of day service operates in a rather different way, in its effect on central station operation, as well as its economy.

"Central stations of the later day are generally so built that nearly all classes of electrical service may be furnished from the same source. This applies not only to electrical apparatus but as well to steam-driven machinery, whether turbines or reciprocating engines, and to boilers. All of this apparatus gives the best results at a certain load point, and the more nearly this condition is maintained the greater naturally will be the saving in coal and water, and the greater the returns in money. There are at this day some practical limitations to combined plants, but the efforts of manufacturers and designers will surely remove these in time."

It has been understood that the supply of current for the operation of electric railways offers an opportunity for lighting stations to add to their day load, but this is not as important a source of business as might be supposed. The load is very variable and the peaks of the railway load come very close to those produced by the demand for light, especially during the winter months, so that, unless storage batteries are installed, there is not much to be gained by the combination. It has generally been found preferable for railway stations to instal their own power houses, leaving the lighting stations to derive their day load from sources which interfere less with their normal night business.

"The usual method of adding day load is by the sale of commercial electric power for operating elevators, pumping plants, factories, small refrigerators, etc., and this class of day load is most profitable, being what is necessary for a central station heating plant, and in itself giving good returns at the station. It is the type of load most easily added to any plant, whether operating single of polyphase alternating or direct current. Many of the plants in the smaller towns still operate their single-phase equipment of former days, and are in good condition to use it to advantage in this day of improved single-phase motors. The single-phase motors now on the market, possess all the characteristics of the reliable direct-current series motors, combining great starting torque with low starting current, requiring less in transformer installation and cutting down transformer losses, which on polyphase systems with the necessary two or three transformers for each installation, are a considerable item of the idle load on the plant."

In discussing the subject, Mr. W. J. Greene compared the conditions existing today with those obtaining fifteen years ago.

"It must be remembered that this data is from operative conditions existing fifteen years ago. Advancement in the art of central station operation and management would enable any plant at this time to do much better, and taking these facts into consideration, I believe the above percentages are applicable and will give conservative results if used in estimating the effect of a day service on any plant. There are many uses to which electricity can now be applied that were not available fifteen years ago. Cities in which no gas plants are installed give unlimited possibilities for heating devices, a field that is slow to open up in gas-covered cities. Look at this partial list of utensils, now a commercial commodity: flat-irons, curling-irons, cigar-lighters, hot-water urns, coffee-pots, waffle-irons, hot-plates and broilers, oyster-cookers and stewers, toasters, chafing dishes, cereal-cookers, water-boilers, baking and warming-ovens, heating pads, glue pots and soldering-irons. Then look at the special uses to which electricity can now be applied for power purposes that were not available fifteen years ago: alternating-current fan motors, sewing machine motors, bellows, automobile charging sets, etc.; and the effect of a day service in increasing light consumption must not be overlookel. Consumers will be secured as a result of continuous service that could not otherwise be had. As soon as a day circuit is established, a demand will be found for day lighting in basements, halls, closets, bank vaults and parts of stores. We find that stores use current more and more in the day time, as a result of the darkening of rooms by window decoration.

"Before any plant undertakes a day service, the economical equipment of the power-house and the distributive system, and rates should be carefully gone over. With suitable equipment the increase in coal burned per kilowatt-hour should be slight, because the coal used in banking and starting fires will go far toward taking care of the dead day load. If the plant is amply and economically equipped for the night run, very little extra investment would be required for day service, possibly an additional boiler in order to provide sufficient time for cleaning. If the plant equipment is not properly arranged for the night run it should be remodeled, but this cost could not properly be charged to a day service. The saving during the night should compensate for the cost of remodeling. Another important investment that should be made before undertaking day service is to install watt meters at switchboard and on all consumers. Here again is an equipment that should be had anyway, and is not chargeable to day service. Stations that are now selling entirely or largely without meters might find the inauguration of a day service a good reason for immediately changing all consumers to meters."

In the electric light business, as in the telephone service, it is most important that the whole subject should be carefully studied when the station is being planned. The demand for current for light and for power should be carefully investigated, together with the extent and direction of probable growth, and before all things it should be remembered that that plant is most profitable which is kept continuously at work. The overhead charges on the idle machine as well as on the idle man keep on all the time, and it should be the business of the commercial electrical engineer to see that the plant is busy every hour in the year, remembering that interest, depreciation, and taxes are never idle.

THE INSULATION OF ELECTRICAL CABLES.

STANDARDIZED RUBBER INSULATION FOR WIRES AND CABLES FOR USE WITH HIGH ELECTRICAL PRESSURE.

John Langan—American Institute of Electrical Engineers.

WITH the enormous development of the electrical industries there has come also corresponding demands for certain materials of construction involved in the production, transmission, and utilisation of electrical currents. There is no doubt that the consumption of copper has been greatly increased by reason of its use as wire, in the construction of electrical machinery, and what is true of the conductor is true also of the insulation. In a paper recently presented before the American Institute of Electrical Engineers by Mr. John Langan, the question of the use of rubber insulation is discussed, with especial emphasis upon the necessity of using precise and carefully framed specifications in order that material of proper quality shall be obtained.

"The effect of the tendency toward high electrical pressure is nowhere more severely felt than in the requirement for insulated wires and cables, for insulation practically controls this feature of electrical distribution. Electrical pressures can, to be sure, be increased to almost any extent, and electrical energy be transmitted to almost any distance; but to control its pathway, to regulate its course, to prevent waste, and maintain safety, this is the problem—the big underlying problem—of all electrical distributions of today. Five hundred volts and under are easily controlled; but pressures of 5,000, 10,000 or 20,000 volts introduce new problems, problems that were not even thought of in the days when 110 volts was considered standard practice.

"On the distributing and not the generating medium, then, depends the success of the present tendency in electrical distribution. A badly insulated wire or cable will imperil the success of any system. Not only must the insulation itself be perfect, it must also be properly tested, properly installed and properly protected. And curiously enough, engineers while examining carefully every other feature of a transmission system, will often pass lightly over the question of cables."

Mr. Langan examines the National Electric Code and the rules of the Board of Fire Underwriters, and shows that these are by no means sufficient to secure satisfactory and durable insulating mediums.

Even if the requirements of these rules were correct there is no authoritative body having the power to enforce them, and it is the opinion of Mr. Langan that the only way in which reliable work can be secured for the consulting electrical engineer is to use proper specifications, and then see that these are carefully carried out on the work under his inspection. The use of definite specifications to insure standardization, instead of depending solely upon a subsequent voltage test, is believed to be desirable, since there are insulating materials which stand a test when new but deteriorate rapidly in service. The use of oil insulation in high-tension switches and transformers is well known, and Mr. Langan calls attention to the manner in which this fact is used to prepare insulating material which may not be of permanent value.

"Certain mineral and vegetable oils will, therefore, stand extremely high pressures, and in this we have a clue and even a proof, why many obviously cheap insulating compounds stand very high potential tests, and yet will, in a short time, break down in actual service. The logic of this anomalous condition is, that when these communicated oils in the compound evaporate—as they will in a short time—the temporary and adventitious virtues they possess disappear also, and the insulation, deprived of this artificial support, quickly falls into disintegration and decay. This is the inevitable history of all such combinations. The situation is somewhat akin to a horse "doped" for a race, who shows a surprising turn of speed for a short distance and then suddenly collapses. From this it will be seen that a puncture test is, in itself, an uncertain proof of dielectric excellence.

"What is it then that constitutes good insulation, and how can we ascertain and know it? This is the all-important question. With this assured, everything else logically follows. The consensus of opinion, derived alike from theoretical and practical experience, is that rubber is the best of all insulating materials. There will, it is believed, be little dissent from this established conclusion. Its use today is practically universal. It has survived the vicissitudes of time and experience, has successfully refuted the claims of all alleged substitutes, and stands today the unrivaled and indisputable factor in transmission, without which electrical progress would be uncertain and precarious. We need not, therefore, resort to any detailed proof of rubber's right to insulating pre-eminence. Twenty years of practical experience justifies the wisdom of its use. In fact, it is the quantity and quality of the rubber in the compound that differentiates the grade and determines the price of every wire and cable on the market.

"But while rubber is the principal feature of good insulation, it is not the only feature. As a matter of fact, rubber in itself is valueless as an insulating medium. The reason for this is that in its native condition it absorbs a certain amount of moisture, and when exposed to the air readily oxidizes. These factors of disintegration naturally preclude its use as a distinct and separate constituent for insulating purposes. But in conjunction with other ingredients, and when allied with sulphur, and properly vulcanized, it becomes not only absolutely waterproof, but indeed, under normal conditions, one might say, indestructible. From this it will be seen that there are two factors involved in good insulation. The fundamental thing is, of course, that the rubber be fine Para. But it does not matter how good the rubber is or how much of it is incorporated in the compound, if the vulcanization is not properly carried out, the insulation will be defective. In fact, it is hardly exaggerating things to say that the art, or the science, of rubber insulation resides chiefly in the proper understanding of vulcanization. This consists in the addition of a certain percentage of sulphur—generally about three per cent—to the rubber and then subjecting the association to a certain temperature for a certain duration of time. The result is vulcanized rubber. Vulcanization, then, is that more or less mysterious factor which gives the rubber longevity, durability and immunity from oxidation when exposed to atmospheric and other conditions. In short, it is what may be called "embalming" the rubber. Without it rubber is absolutely worthless for insulating purposes; with it, it becomes, under normal conditions, virtually indestructible."

Mr. Langan calls attention to the fact that there are two elements in a rubber insulation which determine its quality, one being the amount of fine Para rubber which it contains, and the other the percentage of extractive or resinous matter. The higher the percentage of resinous matter the lower the quality of the rubber, the life of the rubber being in inverse relation to the proportion of resinous matter.

The test for the physical quality of rubber consists in its ability to return to its original length after repeated stretching.

It has been the practice to consider the physical properties of rubber by the original strength, but Mr. Langan calls attention to the fact that the ultimate strength is deceptive, and that rubber which may have a high strength when new may also be poor stuff not long after. The vulcanizing affects the character of the material very materially. If over-vulcanized it will be hard and brittle, and if under-vulcanized, flabby and inert. The best test is that of recovery after stretch, and Mr. Langan maintains that a good sample should fully recover after being stretched to three-and-one-half times its original length, a test not unlike that also involving the elastic limit used for determining the real value of other materials of construction, especially the metals.

The specifications suggested by Mr. Langan are too long to be given here in full, but they include the requirement that the insulating material should contain not less than thirty per cent of fine Para rubber, and not more than five per cent of resinous matter, and contain no shoddy, reclaimed rubber, rubber substitutes, or the like. He also gives tables of the insulations tests to be applied for various thicknesses of wall, for various purposes.

Puncture tests naturally form a part of the question, and Mr. Langan treats these about the same as the general engineer considers ultimate rupture test of materials of construction; that is, as liable to reach the point of injury, without passing it, and thus leaving the material in condition to break down with a much lighter stress.

"It is obvious that a cable may be well made up of very poor material, or it may be imperfectly made up of the very best material. In the one case there is good workmanship with poor material, and in the other bad workmanship with good material. In the first case the cable is intrinsically poor and in the second it is intrinsically good, but imperfectly made up. This imperfection may be slight or considerable; it may be due to a piece of gravel or an air bubble in the compound. In a case like this nothing but a puncture test will discover the fault. But the test should be nominal, and there is no need of pushing it to the point of rupture. If there is any weakness or imperfection, 5.000, 10,000 or 15,000 volts depending on the thickness of the wall of insulation will discover it after one minute's application.

"It may be laid down as a safe, general rule that a puncture test should never exceed double the working pressure, but this is true only up to a certain limit, say, 15,000 volts working pressure. After 25, 000 to 30,000 volts are reached the temperature increases so fast that it becomes increasingly destructive to the vitality and durability of the insulation.

"Much of the present tendency for high potential and breakdown tests is the result of an altogether erroneous comparison with tests imposed on paper-insulated and similar cables, which must, of course, be lead-covered before any test can be made. Such tests are of necessity "dry tests," whereas rubber-covered cables, on the contrary, are soaked in water and tested before the tape, braid or lead is applied. For this reason it is hardly an exaggeration to say that double the potential imposed on a paper cable is no more exacting than half the amount applied to a rubber cable. To expect, then, on a rubber cable anything like the same strain that is ordinarily put on a paper cable would be, in effect, expecting rubber to stand double what paper stands.

"In saying this there is no intention whatever to institute comparisons between rubber and paper or detract in any way from the merited recognition accorded to paper for certain work. All that is intended is merely to point out the fallacy of comparing tests that, in their very nature, admit of no comparison."

ELECTRIC CRANES.

THE SUCCESSFUL USE OF THE ELECTRIC CRANE FOR HANDLING HEAVY WORK IN THE IRON FOUNDRY.

American Foundrymen's Association.

POWER cranes have been used in the foundry for a long time, and until electric power was sufficiently developed to be applied to such machines the flying rope and the square shaft were used for traveling cranes, while the hand-operated jib-crane still held its supremacy where smoothness of action and definite control were essential. The development of the electric crane was a natural result of the improvements in the general application of electric power to the driving of machinery during the past fifteen years, and at the present time nearly all travelling cranes in use, both in the machine shop and in the foundry are operated by electric motors.

In a paper presented by Mr. Harry Sawyer before the American Foundrymen's Association the especial applicability of the electric crane to foundry work is discussed, with some remarks which are applicable to cranes in general.

"It is no doubt true that the foundry has set the standard of excellence for electric cranes. Some shops and mills may have heavier loads to handle and require greater speed, but the crane manufacturer recognizes that the perfect control required in the foundry represents a higher state of development than mere requirements of capacity and speed. It should not be understood that good control is not required in mills and shops, particularly in the latter, but as a rule the requirements of the foundry are much more exacting.

"The conditions under which a foundry crane is operated are less favorable to continued good service than the conditions in a machine shop. It is more subject to overload, and the dirt and dust necessitate more careful attention. Furthermore, the men directly responsible are usually less familiar with machinery, with the result that the crane too often does not have the care it should. It it a mistake to assume that a crane which does the work of an army of laborers can safely be handled and cared for by one of that class. The importance of employing only thoroughly competent and conscientious operators and keeping the cranes in perfect repair cannot be too strongly urged. Prompt attention will reduce the total cost of repairs and the extra cost of careful and competent men will be saved many times by the more constant service and longer life of the crane."

One of the most important advantages which have resulted from the application of electric driving to cranes is the simplification of the mechanism. Those who are familiar with the machinery of the earlier types of rope of shaft-driven cranes will remember the complicated system of clutches and gearing by means of which the single continuous motion, delivered to the bridge from the line shafting, was converted into the three co-ordinate movements of bridge-travel, trolley-travel, and hoisting. The first electric cranes were made with but a single motor, so that the full advantages of the new power system were not realised. It soon appeared, however, that the true solution of the problem was to use a separate motor for each separate function, and at once the whole mass of machinery fell away before the modern three-motor crane, in which a separate motor is used for the operation in each one of the three dimensions by which the entire space beneath is covered.

Mr. Sawyer discusses the present tendency toward excessive operative speeds, showing that the assumed gain in time is often neutralised by the natural limitations which are governed by the work.

"Two objections may be offered to excessively high speeds. First, the accidents that are likely to result from putting a high speed crane in the hands of an incompetent operator often cause the loss of much more time than is saved by the higher speeds, and greatly increase the cost of repairs. Second, if the crane is not usually run at full speed there is a constant loss of power in the rheostat, and the unnecessary wear and tear on the controller parts, both of which cause expense and loss of time. The above comparisons apply with the most force to cranes in mills, where much higher speeds are necessary and practical.

"Next to the requirement of necessary strength in all parts for absolute safety, the most important point to be considered is perfect control of the hoisting mechanism. This depends upon three parts: the motor brake, the load brake and the controller. The motor brake is released by the current which operates the motor, and should require only as much current as is necessary to drive the machinery without load. It should be sufficiently powerful to bring the armature to a stop promptly, but without shock, when the current is interrupted.

"The load brake is a far more important part. It must allow the machinery to run freely in hoisting, but prevent the load from descending, except when the motor is run in the lowering direction. In most if not all forms of load brakes now in use the brake is applied by the action of the load. They may be divided into two classes: one in which the brake pressure is not reduced in lowering, but the motor acts with the load to cause the brake to slip, and the other in which torsion of the motor in the lowering direction reduces the pressure between the surfaces, allowing the brake to slip and the load to descend. The most common of the first class is the enlarged step bearing on a worm shaft. It can be used only in connection with worm gearing. It is a very simple and may be made a very satisfactory working brake. The most serious objection to it is this: If proportioned to give a fair margin of safety with the best conditions of lubrication, it will take considerable power to lower with moderate or poor lubrication, for the motor must overcome any excess of holding power over that necessary to sustain the load. This extra work in lowering means loss of time and power and greater wear of parts.

"Of the second class there are the coil type and the disk type. Both have their advantages and disadvantages. The disk type is more substantial in construction, gives better distribution of pressure over the friction surfaces, and consequently a much lower unit pressure; and as the pressure is strictly in proportion to the load it gives higher speeds in lowering light loads. It has this disadvantage, that it is more sensitive to irregularities in lubrication.

"In the coil brake the pressure and wear are concentrated principally at one end. While the brake is applied by the action of the load, the pressure and resistance to slipping are not strictly in proportion to the load. The torsional effort of the motor to release the brake is dependent upon the proportions of the brake parts and not upon the load, hence the speed in lowering is approximately the same for all loads. Both types are used by reputable builders and both may be designed to give good results.

"A good controller is indispensable to a satisfactory crane. The essential parts of the controller are the resistances and the means for varying the amount of resistance in the circuit according to the speed and power required. The most common practice is to divide the resistance into sections, connect the sections together in series and connect each section to one of a series of corresponding contacts. A brush is arranged to pass over these contacts, cutting more or less of the resistance into or out of the circuit. Various materials may be employed and details used to obtain the desired result, but certain conditions must be complied with if satisfactory results are to be secured."

The development of the modern power crane is but one example of the manner in which the laborious work which was formerly performed by human effort is being relegated to machines controlled by skilled operators. It is a well-known fact that the modern work-shop contains far fewer men in proportion to the output than was formerly the case, although the individual grade of the operatives may be of a higher class. There is no especial merit or dignity in brute labor, however much this may formerly have been assumed to be the case, and every mechanical appliance which replaces the effort of human muscle must be considered as making for the general elevation of the race by rendering it more than ever necessary for man to use his brains rather than his hands. The art of *directing* the great sources of power in Nature is the true province of the engineer, and that art accomplishes its end in just such degree as it is exerted for the "use and convenience of man," and not for his misuse and inconvenience.

REFUSE DESTRUCTORS.

THE ECONOMICAL DISPOSAL OF MUNICIPAL REFUSE BY FIRE AND THE UTILISATION OF THE RESULTANT BY-PRODUCTS.

Institution of Engineers and Shipbuilders in Scotland.

THE destruction of municipal refuse by fire is a very old question, but it has become a renewed subject for discussion since it has been found practicable to derive a fair return from the by-products and thus materially lessen the cost of the operation. In a paper presented recently before the Institution of Engineers and Shipbuilders in Scotland by Mr. H. Norman Leask the present status of the subject is discussed, and some abstract of this examination is here given.

Mr. Leask reviews rapidly the construction and operation of the earlier refuse destructors, and then proceeds to discuss the principles upon which the more improved modern types have been designed.

"The call for better sanitary measures on the Continent, and in fact all over the world, has given an impetus to the construction of furnaces by foreign makers, notably in Germany and Belgium. Lately a competition was held in Brussels, and no less than five new makers of destructors submitted schemes, four German and one Belgian. No doubt these furnaces are largely based on British practice, and it is also fairly certain that British engineers dealing with the question will have to regard German engineers as worthy rivals at no far distant date.

"The larger proportion of early destructor plants in England was operated by natural draught, and the rate of burning does not appear to have exceeded six tons per day of twenty-four hours on a grate area of about thirty square feet. About the year 1894 forced draught was first applied systematically to refuse furnaces, and a much higher burning capacity with higher temperatures were obtained.

"Anyone doubting the advantage of the ues of mechanical means for supplying the air for the support of combustion, cannot but be struck by the increase in the rate of burning and consequent higher temperatures obtained in the destructor field by this means. This rate of burning has now gone up, and 60 pounds per square foot of grate area per hour is quite common, and has even passed 85 pounds, temperatures have also risen from a mean of perhaps 800 degrees F. to a mean of nearly 2000 degrees F., in some cases rising higher than 3000 degrees F. Water evaporated per pound of refuse has also risen from *nil* to over 2½ pounds from and at 212 degrees F."

The constitution of refuse naturally varies in different localities, so that it is impracticable to determine upon any standard design of destructor, and the appliances should be modified, especially with respect to the proportion of air admitted, according to the nature of the material to be consumed.

"The destruction of refuse is nothing more or less than the combustion of poor fuel. The difficulties to be faced arises out of the abnormal quantity of mineral matter, the high percentage of moisture and the relatively small quantity of combustible matter contained in the fuel.

"The manner in which the problem has been solved may be divided into two distinct groups, as already stated the distinctive feature of the earlier one being the division of the furnace into a number of isolated chambers, generally called cells, the other making provision for a furnace chamber common to a number of grates. The author would submit as incontrovertible that the latter type has given the better results from the standpoint of high temperatures, more regular maintenance of the same, and more complete combustion with a constant higher evaporative efficiency.

"It is claimed for the isolated system that repairs can be carried out without affecting the operation of the adjacent furnaces; this, however, appears doubtful if the adjacent furnaces are in full work, as it is by no means uncommon to find the fire brick linings red hot at a depth of nine inches from the working furnace face, and almost impossible to bear one's hand on a wall eighteen inches thick. As the isolated system presents a larger perimeter of firebrick work exposed to the adherence of clinker, the repairs are also likely to be more frequent. In some makes this is obviated to some extent by fixing cast iron boxes through which the air for the support of combustion is passed on its way to the ashpit. The cubic contents of firebrick lining in a furnace of this type is no doubt somewhat greater than with the common combustion space type, and therefore more heat may be said to be stored, but this construction renders it more difficult to obtain a suitable outlet for the products of combustion, the passages being necessarily small, and if high temperatures obtained would rapidly become choked up and almost impossible to clean."

The question of drying or dessicating the material is discussed by Mr. Leask, with especial reference to the plan, sometimes adopted, of allowing the material to be dried out upon a hearth before it is fed into the furnace, utilising the radiant heat for this purpose. Mr. Leask prefers to dry the material by the passage of heat through it as it lies on a grating, and in this respect his experience agrees with that of one of the most successful engineers in the United States, Mr. A. W. Colwell, who employed several superposed grates composed of water-tubes, the down-draught principle being employed, and the material passing through one grate to the next as it became dried and partially consumed, until it was completely burned on the lowest grate. The distilled gases in such an arrangement pass through the successive beds of incandescent fuel, insuring complete and effective combustion.

"There are many ways of obtaining a high temperature in a furnace, and it may seem strange that the temperature can be too high in a furnace, but it is a fact. It may be so high that particles of dust carried into the settling chamber become molten and on solidification require a great deal of labour and force to remove them. One of the simplest means of obtaining a high temperature is to work a furnace with a plenum above the grate bars, that is, combustion under pressure. It is well known that the effect of pressure is to reduce the specific heat of air, and, consequently, when a pressure above that of the atmosphere is created in the furnace, the temperature will rise; as the pressure above the grate seldom equals from half an inch to one inch of water, the calculated rise in temperature resulting from such a process would not be much above 50 degrees F. The actual observed increase in temperature, how ver, is very much greater than this, and is, no doubt, due to the fact that an air supply approximating more closely to the requirements of the fuel enters the furnace, also the entrance of cold air through the doors is absent, and, consequently, the calorific value of the fuel is dissipated over a smaller quantity of air. This method, if adopted, however, has very serious inconveniences. *Firstly*, it is impossible to open any furnace door without allowing an outrush of the products of combustion, and, *secondly*, suitable doors for closing the furnace when in operation, would be difficult to manufacture and maintain. On the other hand, if there is a decided vacuum above the grate bars, on opening a furnace door large quantities of cold air will enter, with a consequent fall in temperature. It will, therefore, be seen that there is some mean point to arrive at which requires nice designing, in order that the best results can be obtained. Other means, however, can be adopted to obtain a higher temperature."

Mr. Leask discusses the important question of the handling of the material in the light of evident experience, showing the difficulties which must be met in this department of the work.

"The most vexed question is that of the best means of feeding refuse fuel into a furnace. Now this fuel varies with the locality, with trades, and with seasons of the year, in fact it may be said to vary hourly, and will consist of such varied material as a load of vegetable matter or fruit, load of paper, straw or ashes, leather cuttings, oilcloth cuttings, rolls of oilcloth, mattresses, paper, tins, bottles, fish, slaughter-house offal, etc.

"Five years ago it was common to see expressed in specifications a desire to receive schemes for charging furnaces mechanically, and much money, time, and trouble has been spent in endeavouring to arrive at this desideratum. Up to date it has not been achieved with any marked degree of success, and it may be said, with a great deal of truth, that plants giving the greatest satisfaction are those in which no such mechanical means exist. The material could, of course, be treated primarily, disentegrated and reduced to a uniform size, and then fed into the furnace in a simple manner, the cost of such machinery, and the maintenance and labour attending the same, however, exceed that of charging the furnace by hand. The author has had the opportunity of inspecting such apparatus at work and of verifying these facts.

"It is not a difficult matter to devise a furnace into which large quanities of refuse can be tipped, it is, however, a grave question as to whether it is advisable to proceed in this manner or not, if whole cart loads of refuse are tipped into a furnace no opportunity of selecting and varying the proportion of the material is permitted, nor can it be claimed that the charging of a furnace with a ton of refuse at a time is a scientific way of obtaining good combustion, it must necessarily mean great fluctuations in temperature, and it is questionable whether any saving of labour results. Picture a load of market refuse being discharged into a furnace, and subsequently a load of paper and straw, then a load of ashes, then large quantities of shell fish and tins, can anyone say that such a proceeding can give good results for a very large plant connected to a common chamber, and where it is merely a question of getting rid of the refuse; there might be an excuse for such an arrangement, but under no other circumstances could such a proceeding be justified."

The by-product of a destructor plant is the heat produced, which can be delivered to an associated boiler installation, and employed for the generation of electrical current. Mr. Leask gives detailed reports of tests of a number of plants showing that it is entirely practicable to evaporate from 1.5 to 2 pounds of water from and at 212 degrees F. per pound of refuse destroyed.

EFFECTS OF FIRE ON BUILDING STONES.

EXPERIMENTAL TESTS UPON THE RESISTANCE OF BUILDING STONE TO THE ACTION OF HEAT, WATER AND MECHANICAL STRESSES.

W. R. Baldwin-Wiseman—Surveyors' Institution.

WITH the disastrous fires which have occurred during the past few years, culminating in the conflagration which followed the earthquake at San Francisco, it has become more and more evident that a better knowledge of the fire-resisting properties of materials of construction is essential. A most valuable contribution to the literature of the subject appears in a paper presented before the Surveyors' Institution by W. R. Baldwin-Wiseman, giving data and results of tests which he has made upon a variety of building stones, both as to their original resistance, the direct effects produced upon them by exposure to high temperatures, and the ulterior effect of exposure to heat upon their subsequent strength.

The author of the paper shows how meagre the present stock of reliable information is upon the subject, and in his preliminary remarks gives some very sound views upon the matter.

"The temperature and destructiveness of any conflagration are so entirely dependent upon the plan of the building, the nature and disposition of the material used in its construction, the nature of its contents, the time, location and cause of the fire, and other incidents, as to preclude all possibility of reduction to any standard formula, and a study of the stresses which a building has to withstand during and after a severe conflagration is also so complex a problem as to be practically indeterminate if viewed as a whole; but if one resolves it into separate considerations of design and material, it is brought more within the bounds of solution, and the range of every-day practice in design.

"For this reason, I regard as practically valueless all experiments which involve the construction of, say, a model room, and its destruction by fire, when, in many cases, the building material of which it is composed is comparatively fresh, the wall and floor stresses are trivial, and the internal space is utterly inadequate for the generation of a really serious fire. Far more profitable experience would result from a careful inspection of all interiors after the extinction of a fire, for much information as to the temperature of the fire could be obtained by a careful examination of the condition, fused or otherwise, of the metallic fixtures. Thus, for instance, lead melts at 326° C., aluminium at 625° C., and brass at 1,000° C., so that if, on investigation, it was found that the two first-named had melted, and the last-named had not, one would know that the temperature in the places in which they were severally situated exceeded 625° C., did not exceed 1,000 ° C.; and by tabulating the records of the intensity and destructiveness of fires in various buildings of similar plan, structural arrangement and trade, one would create an almost invaluable record for reference."

The scope of the researches was limited to a number of British building stones, all of which are described in detail in the original paper, but the conclusions may be accepted as generally applicable to building stones of similar character in other parts of the world.

In brief, the following points were considered:—

First. — The transverse and crushing strength of stone;

(A) When thoroughly dried in the steam oven so as to expel all absorbed water held in the pores, but not the water of crystallisation;

(B) When thoroughly soaked in water;

(C) When subjected for various definite periods to constant temperatures ranging from 500° C. to 820 C., and either slow cooled in air or suddenly cooled by immersion in cold water, immediately upon removal from the furnace, the latter case being intended to somewhat imitate the conditions when a jet of water is directed upon a burning building.

Second.—The expansion of the stone with increase of temperature from 20° C. to 300° C., and the permanent alteration in dimension on subsequent cooling.

The tabular statement generally given about the fire-resistance and of depreciation in strength of stones after exposure to heat, is that of Dr. Cutting, in which, placed in a decreasing order the following relations are given:

1. Marble
2. Limestone
3. Sandstone
3. Granite
5. Conglomerate.

These relative resistances are given under the assumption that water is not applied. The accuracy of this table is by no means borne out by the researches under consideration, and indeed, the variations in the physical structure in various members of these classes preclude the possibility of any such generic grouping.

Broadly, the stones included in the present tests included six sandstones, nine limestones and calcareous freestones, and three of igneous origin. The test pieces were dressed to prisms one inch square and six inches long, except a few samples in which the cross section varied slightly, the length being the same. The dimensions were determined to 0.1 millimetre, and the weights carefully taken this latter determination being for use in connection with the moisture absorption tests.

The strengths were determined by crushing tests and by transverse breaking tests, while the heat tests were made by placing the specimens in an electric-resistance furnace made of mica and asbestos, about which a coil of chemically pure platinum wire was wound. The temperature was determined by a Callendar-Griffiths thermometer, the whole apparatus being capable of producing and maintaining uniform temperatures from 500 degrees to 820 degrees C.

A similar furnace, equipped with measuring appliances, and using mercurial thermometers for the lower temperatures involved in making the expansion determinations, was also used, and the tests appear to have been conducted with great care and judgment.

"Considering first those experiments for the determination of the strength of the stone, there were several phenomena worth recording. Many of the Doulting, Portland, and Bradford test-pieces emitted a peculiar crackling noise during the first five minutes after insertion in and removal from the furnace; the York stone changed in colour form a straw yellow to a terra cotta red, due possibly to a chemical change in the composition of the iron oxide in the cementing material of the grains of the stone. The Diabase changed from a dark greenish black to a dirty yellowish green; the Monks Park, Portland, Hopton Wood, and Boxground stones became chalky in appearance and somewhat lighter in colour; the Hopton Wood stone became internally mauve-grey in colour, and developed brown stains here and there; the Bradford and Bath oolites lost their fresh crisp appearance, became more or less earthy, and developed irregular red stains round some of the larger grains.

"The Aspatria test-pieces, soon after their insertion in the furnace, gave off a dense smoky cloud, which soon after flashed and burnt steadily, with a smoky yellow flame for about a minute. By trituration of some of the crushed stone with alcohol and subsequent distillation of the alcohol, a viscous amber-coloured combustible oil was collected.

"Several stones, such as Doulting, disintegrated in the furnace or immediately after removal therefrom. Others such as Doulting or Daresbury disintegrated immediately on immersion in or removal from the water, and one Daresbury retained its form during cooling, and carried its own weight upon the supports, but broke when the stirrup, weighing only two pounds, was carefully placed upon it, and fell as a mass of incoherent sand to the floor.

"Some, such as Doulting, Carrara marble, the Red and, in a less degree, the Grey granite, the Bradford and Bath oolites, and the Daresbury sandstone, had but little cohesion, and crumbled to powder when touched, or when more or less coarsely rubbed with the hand.

"Several Carrara marbles warped upon cooling, arching slightly; others, such as Hopton Wood, Monks Park, and Boxground stones, retained a sharp arris but the sides caved in, and cracks more or less deep developed at right angles to the direction of greatest length of the test piece."

The results of the tests for deterioration of strength by exposure to heat gave information fully confirming the statement that no general classification is practicable. Thus the York stone, a fine grained millstone grit, composed of siliceous grains embedded in siliceous cement, showed an original crushing strength of 550 tons per square foot and a transverse resistance of 70 tons. After exposure to high temperature the resistance to crushing became only 36 per cent of the original, and the transverse strength 65 per cent. The Red Mansfield stone, a calcareous sandstone, had a much lower initial resistance, its crushing strength being 160 tons pere square foot, and the transverse resistance 40 tons, but after exposure to high heat, and slow cooling in air, the crushing strength was not diminished, while the transverse strength was 62 per cent of the original. When cooled with water the crushing and the transverse resistances were 87 per cent and 60 per cent respectively, of the originals. These are only samples of the various results obtained, and similar discrepancies appear among the calcareous freestones. The chalks were practically ruined by heat, there being no residual strength worth mentioning. Marbles varied materially in their strength after heating, but showed more nearly the same depreciation for both crushing and transverse strength than some of the other stones. Granites appear to be most useless in resisting heat. A red granite, with initial crushing and transverse strengths of 350 tons and 90 tons per square foot respectively, depreciated to less than 10 per cent of its original resistance.

One of the best results was that given by a quartzite, or dense metamorphosed sandstone, belonging to the Permian formation, this having a crushing strength of 240 tons per square foot and a transverse resistance of 150 tons. After exposure to heat, whether cooled in air or with water, it retained 71 per cent of its compressive strength, and about 90 per cent of its transverse resistance.

The paper of Mr. Baldwin-Wiseman contains much valuable information regarding the expansion and swelling of stones under heat, as well as the effects of moisture, which we have not space here to discuss, but, apart from the detailed results for the various stones tested, we append his general conclusions, with regard to fire resistance and prevention in buildings.

The points of primary importance in determining the most efficient design for fire resistance are:

1. That the edifice should in no wise be flimsy.

2. That it should be constructed of stone possessing an uniform or fairly uniform co-efficient of expansion, and retaining a considerable strength after subjection to high temperatures.

3. That all combinations of different stones should be avoided as much as possible.

4. That combinations of stone and metal should be avoided, especially when the former rests directly upon the latter, even when the metal is entirely enshrouded in stone, for stone acts as a fairly good conductor or heat.

5. That stair wells and lift wells should open as little as possible on to the main building, and should preferably be enclosed and glazed with wired glass from basement to roof.

6. That floor areas should not be unduly large nor corridors unduly long.

MODERN TRAIN LIGHTING.

THE USE OF INCANDESCENT GAS MANTLES FOR THE ILLUMINATION OF RAILWAY PASSENGER CARRIAGES.

H. Gerdes—Glaser's Annalen.

THE subject of the lighting of railway carriages is a matter which has been studied by engineers for a long time, and the continual improvement which has been made bears witness to the success which has attended the application of scientific methods to the question. The early trains were lighted with candles, and we believe that this primitive method has not been entirely abandoned in some of the carriages of the lower grades on railways in eastern Europe. Oil lamps are still used to a large extent, and they have many advantages, especially that of entire independence from any external disturbance, besides moderate cost in operation. With the demands from passengers for better lighting there has been introduced the system of compressed gas-lighting. including the enriched gas, Pintsch gas, acetylene, and kindred systems, followed by electric lighting systems. Numerous methods of supplying electric light have been devised, involving the sole use of storage batteries, the employment of independent dynamos on the engine or in the baggage car, and the use of separate dynamos, driven from the axles of each car, all of these involving the use of some accumulator reserve for use during long stops, or while cars may be detached from the train.

Gas lighting still maintains its supremacy in the greater portion of trains in Europe and America. and with tho efforts which are directed towards its improvement it will probably still continue to be employed, at least, until electric traction supersedes the steam locomotive for main-line service.

In a paper recently presented by Herr H. Gerdes before the German Society of Mechanical Engineers, the question of applying the incandescent gas mantle to the lighting of railway carriages is discussed, and some designs are shown which lead to the belief that this efficient and economical method of illumination may be very useful for this purpose.

The use of a mantle composed of the oxides of certain metals of the earths for the purpose of converting the heat of a burning gas into light energy is now about twenty years old, and there is little or no doubt that this invention, due to Dr. Auer von Welsbach, has been the means of enabling gas lighting to compete successfully with electric lighting. The fragility of such mantles, however, has generally caused it to be supposed that this form of light was unsuited for situations in which there was much vibration, such as on bridges and similar locations, and especially in railway trains. Later experiments have shown, however that this opinion was not altogether correct, and with the improvements in the manufacture of the mantles, and with especial designs for suspension, it has been found possible to use such burners on trains to marked advantage.

The earlier experiments with incandescent mantles in railway carriages were made in Germany, using several mantles of the ordinary form within a single glass lantern. This form involves the employment of a metallic support beneath the mantle, with its accompanying shadow, and hence the later installations have been made with the inverted burner, the mantle being of the spherical form, and the gas supply delivered from above. Herr Gerdes gives a number of illustrations, showing the detailed arrangements of such burners, as used on the railways of France, Germany, and Austria, as well as in England and gives a list of more than 3,500 cars which have been thus equipped.

The only competitor of the incandescent gas burner for train lighting is the electric light, and here the operative cost is distinctly against the electric system, besides the necessity for providing storage battery or other reserve when the cars are at rest or separated from the locomotive. There is no doubt that the incandescent light is satisfactory to the passengers, while photometric measurements show that a greatly increased degree of illumination is given at a far lower cost than with either electricity of with ordinary gas burners, using Pintsch gas or gas enriched with acetylene.

The principal points to be provided for with the incandescent gas light are the method of lighting, the easy replacement of the mantle in case of failure, and the proper air supply and control of illumination. These points appear to have been fully met in the burners now in use in France and Germany, and there appears to be no reason why such high grade illumination may not be supplied on all railway trains at a lower cost to the companies than the inferior lighting obtainable from other sources.

The demand for better train lighting in Germany, especially for the first-class corridor trains, has been such as to cause the introduction of auxiliary electric reading lamps, while retaining the gas installation for the general illumination. It has also been thought necessary to retain the gas-lighting because of the liability to interruption of the electric current. The expense of this double system is naturally much greater than the employment of gas alone, and effort has been made to devise a lighting system which should utilise the existing equipment and give better results.

This appears to have been found in the inverted incandescent gas burner, to which the piping and gas storage tanks already on the cars are readily applicable. The pressure required for the inverted burner is somewhat higher than that used for ordinary gas burners, the best results being attained with a pressure of about 150 millimetres of water. The consumption of gas, however, is decidedly lower, since a Hefner candle is obtained from 1 litre of common illuminating gas, while with the ordinary burner 3 litres are required for enriched gas, or 2.5 litres for undiluted oil gas.

A point to be taken into account is that, with the incandescent burner it is the heating value of the gas which is desired, and hence it is not practicable to use the burner for oil gas, enriched gas, or common lighting gas indifferently, and it is desirable to have the incandescent burner adjusted for the quality of gas provided, and then maintain this standard as uniform as practicable.

THE ENGINEERING INDEX

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IN THE ARCH OF APPLIED SCIENCE."

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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Arch.

The Pennypack Creek Concrete Arch Bridge, P. & R. Ry. Illustrates and describes the construction of a bridge of five semi-circular arches, each of 60 ft. clear span, with an elevation of 80 ft. above low water. 1500 w. Ry & Engng Rev—May 19, 1906. No. 76715.

Three-Hinged Concrete Arch Bridge, Brookside Park, Cleveland, O. H. F. Hackedorn. Illustrates and describes the first three-hinged concrete arch bridge constructed in the United States, which is also the flattest semi-elliptical arch ever constructed. 1300 w. Eng News—May 10, 1906. No. 76616.

Austria.

Austrian Railway Ministerial Order of 28 August, 1904, Concerning Railway Bridges, Over-Bridges, and Approach Road-Bridges, with Iron or Wood Superstructures. Tables. 14000 w. Bul Int Ry Cong—April, 1906. No. 76953 E.

Bascule.

A Page Bascule Bridge at San Francisco, Cal. Illustrated description of a drawbridge of the trunnion type, with two leaves. 1500 w. Eng News—May 17, 1906. No. 76680.

Havre-de-Grace.

The Pennsylvania Railroad Bridge at Havre-de-Grace, Md. Illustrated description of a steel bridge under construction across the Susquehanna River, which represents the most advanced methods. 3000 w. Eng Rec—April 28, 1906. No. 76414.

Maintenance.

The Strengthening and Maintenance of Early Iron Bridges. William Marriott. From Proceedings of the Inst. of Civ. Engrs., with discussion and correspondence. Considers especially the West Lynn bridge over the River Ouse, and the Potter Heigham bridge, over the River Thurne. Tables and Ills. 17000 w. Bul Int Ry Cong—April, 1906. No. 76952 E.

Memorial.

The Hendrick Hudson Memorial Bridge. Illustration and information of a proposed bridge to span the Harlem River where it connects with the Hudson, to be built in commemoration of the tercentennial of the discovery of the Hudson River. 1200 w. Sci Am—May 5, 1906. No. 76498.

Reinforced Concrete.

A "Double-Drum" Reinforced Concrete Arch Highway Bridge. Daniel B. Luten. An unusual design at Muncie, Ind., is illustrated and described. 1200 w. Eng News—May 3, 1906. No. 76477.

A Reinforced Concrete Girder Highway Bridge of 40 Ft. Span. Daniel B. Luten. Illustrates and describes a new bridge built on abutments considered sufficiently good, which had formerly supported a wooden truss. 2000 w. Eng News—May 10, 1906. No. 76620.

Reinforced Concrete Highway Bridges on the Big Four. Illustrates two interesting designs in Illinois, describing details. 500 w. R R Gaz—May 18, 1906. No. 76745.

Reinforced Concrete Trestlework Viaduct for a Spanish Mineral Railway. Brief description, with illustrations, of two trestlework viaducts near Seville, Spain, and also of an ore-loading pier. 600 w. Eng News—May 17, 1906. No. 76675.

Short Span Concrete Bridges on the Long Island Railroad. Reinforced-concrete structures designed to carry the heaviest trains and locomotives at high speed are described. Ills. 1200 w. Eng Rec—May 19, 1906. No. 76739.

Rhine.

New Bridge at Basle. An illustrated description of the fine stone bridge over the Rhine, recently completed, and the methods of construction. 1700 w. Engr, Lond—April 20, 1906. No. 76451 A.

Viaduct.

Replacing the Ashtabula Viaduct. Describes the old structure and the new one made necessary by the increase in traffic and in weight of locomotives. Ills. 3500 w. Eng Rec—May 19, 1906. No. 76732.

CONSTRUCTION.

Building Details.

Dome and Floor Construction in the United States War College. Briefly describes this fine building in Washington, D. C., which is interesting on account of the very small amount of steel required for a structure of its size and containing so many wide spans. Arch ribs of the Guastavino type were used. Ills. 1500 w. Eng Rec—May 5, 1906. No. 76527.

Caissons.

The Use of Caissons in Bridge Building with Remarks Upon Compressed Air Illness. Thomas Oliver. Principally a discussion of caisson disease; its prevention, symptoms, treatment, etc. Discussion. 10000 w. Jour Soc of Arts—May 11, 1906. No. 76711 A.

Coffer Dams.

Economy of Steel Sheet Piling for Coffer Dams for Bridge Piers. Julian Griggs. A previous account of the construction of a bridge near Chillicothe, Ohio, using steel sheet piles for coffer dams has been given, and the cost is compared with the old coffer dam constructed on the same site in 1885, by the writer. 1300 w. Eng Rec—May 5, 1906. No. 76522.

Custom House.

Some Structural Features of the New Custom House at New York. Outline description of the building, illustrating details of interest, and describing special features. 2500 w. Eng Rec—May 19, 1906. No. 76736.

Dam.

The Pedlar River Concrete Block Dam, Lynchburg Waterworks. Illustrated detailed description of the construction of this dam in Virginia. 2800 w. Eng Rec—May 12, 1906. No. 76646.

Fireproofing.

Fireproofing and Insurance. Edward T. Cairns. A discussion of the position concrete is to occupy in the art of fireproof construction. 4200 w. Munic Engng—May, 1906. No. 76910 C.

Fireproof Domes and Stairways. George E. Walsh. An illustrated article showing examples of the use of terra cotta hollow tiles in the construction of ceilings, domes and stairways. 2700 w. Ins Engng—April, 1906. No. 76485 C.

Notes on the Fireproofing in San Francisco Buildings After the Fire. B. B. Holland. An illustrated report of a number of buildings of fireproof construction, examined by the writer. 2000 w. Eng Rec—May 26, 1906. No. 76957.

Floors.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. Discussion of paper on this subject by John S. Sewell. 12000 w. Pro Am Soc of Civ Engrs—May, 1906. No. 76934 E.

Foundations.

The Steel Foundations of the Title Guarantee & Trust Co. Building, New York. Describes details of foundation work fr a steel-cage office building in New York City, especially the methods adopted for excavating below the water level. 1400 w. Eng Rec—April 28, 1906. No. 76415.

Framing.

A Study of Statically Indeterminate Frameworks (Studie über das Statisch Unbestimmte Raumfachwerk). Josef v. Gerstenbrandt. Discussing especially the framing of polygonal cupolas and similar structures, with analytical and graphical solutions, for various loadings. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 28, 1906. No. 76836 D.

Hotel.

The Hotel Blenheim. J. Fletcher Street. Handsomely illustrated descripton of a new type of construction used for a fine hotel at Atlantic City, N. J. It is an armored concrete and tile construction, and was built in six months, at a cost of $126,000. 2200 w. Brickbuilder —April, 1906. No. 76506 D.

Piers.

Novel Steel Pier Construction at Lome, Africa. Brief illustrated description. 400 w. Eng News—May 24, 1906. No. 76782.

Piles.

Manufacture and Use of Concrete Piles. Henry Longcope. Read before the Cement Users Assn. Reviews briefly the attempts with piles other than wood, and the development of this satisfactory system of construction now in use. 2300 w. Sci Am Sup—May 12, 1906. No. 76632.

Reinforced Concrete.

Economies in the Use of Reinforced Concrete. E. P. Goodrich. Discusses various methods of reducing cost; a solution of the centering problem; and the use of under steels and adaptability of the molds. Ills. 2500 w. Cement Age —May, 1906. Serial. 1st part. No. 76517.

Suggested Plans for Reinforced Concrete Earthquake-Resisting Fireproof Building Construction. Editorial discussion of the behavior of this material in the recent California earthquake and fire, and its use for building construction, with a letter from John Hawkesworth. 3000 w. Eng News—May 24, 1906. No. 76784.

The Advantages and Limitations of Reinforced Concrete. Summary of a paper by Charles S. Hill read before the Portland Cement Mfrs., reviewing the merits and defects of this material. 1000 w. Sci Am—May 12, 1906. No. 76626.

The Rational Proportioning of Structures in Ferro-Concrete. Gives a note concerning methods of verifying the dimensions proposed for armored concrete works on the Coignet system, which may also be applied to other systems. 1500 w. Engng—May 4, 1906. No. 76670 A.

Typical Systems of Reinforced Concrete Construction. Remarks on the adaptability and economy of this material, with illustrated descriptions of typical systems of construction. 4000 w. Sci Am—May 12, 1906. No. 76627.

Retaining Wall.

Difficult Reinforced Concrete Retaining Wall Construction on the Great Northern Railway. C. F. Graff. Illustrates and describes the methods pursued in building the retaining wall and fill at Bridge 123, which is 25 miles west of Summit, Montana. 5700 w. Eng News —May 3, 1906. No. 76472.

Roads.

The Drainage of Earth Roads. Abstract of a Bulletin by Prof. Ira O. Baker, published by the University of Illinois. Considers tile drainage, side ditches, surface drainage, and maintenance. 4500 w. Eng Rec—May 5, 1906. No. 76525.

Roofs.

For Good Tin Roofing. W. B. Goddard. A discussion of the kind of material, preparation, application and finishing, with comments. 3000 w. Met Work—May 12, 1906. No. 76594.

Moving and Raising an Old Wood and Iron Roof. Describes an interesting piece of work in connection with alterations at the Riding Club, 59th St., New York City. Ills. 1000 w. Eng Rec—April 28, 1906. No. 76418.

San Francisco.

Comments of Californian Engineers on the Earthquake and Fire. Edward M. Boggs. Notes on the destruction, and damage, with illustrations showing effects. 3200 w. Eng Rec—May 5, 1906. No. 76523.

Comments of Californian Engineers on the Earthquake and Fire. An account of the earthquake, by Prof. Frank Soulé, with short notes from a number of writers. Ills. 2800 w. Eng Rec—May 12, 1906. Serial. Part I. No. 76648.

Effects of the Earthquake and Fire Upon the City of San Francisco and Its Buildings. Brief illustrated account. 1200

w. Sci Am—May 19, 1906. No. 76688.

Injuries by Earthquake to the Buildings of Stanford University. Gives an official statement, with illustrations, showing the damage to these buildings. 1500 w. Eng News—May 10, 1906. No. 76617.

Notes on the Californian Earthquake. Reports from Carl Leonardt, by the State Board of Architects, and by the Home Fire Insurance Co. Ills. 2000 w. Eng Rec—May 19, 1906. No. 76733.

San Francisco in Ruins. General views and maps with an account of the devastation wrought by earthquake and fire. 8000 w. Ins Engng—May, 1906. No. 76795 C.

Some Effects of the San Francisco Earthquake on Water-Works, Streets, Sewers, Car Tracks and Buildings. Charles Derleth, Jr. An illustrated article showing the damage wrought, with explanation of the fault line along which the worst effects are found. 5800 w. Eng News—May 17, 1906. No. 76683.

Some Lessons from the Earthquake. S. B. Christy. Discusses principally the ruin due to the fire, and how much of it could have been avoided; offering suggestions for the rebuilding of the city on a safer and improved plan. 2000 w. Min & Sci Pr—April 28, 1906. No. 76637.

Some Views and Lessons of the San Francisco Disaster. An illustrated article showing the effects of earthquake and fire, and discussing the construction work that best stood the test. 2000 w. Sci Am—May 12, 1906. No. 76631.

The California Earthquake: Movements Along the Santa Cruz Fault Line. John C. Branner. Explains the geology of the region, showing that the earthquake disturbance was due to the geological structure. 700 w. Eng News—May 17, 1906. No. 76682.

The Cause and Nature of Earthquakes. G. K. Gilbert. Remarks on the origin of earthquakes and the nature of the vibrations. 800 w. Min & Sci Pr—April 28, 1906. No. 76636.

The Earthquake at San Francisco. W. G. Mitchell. An interesting account of the damage as viewed by the writer. 3000 w. Am Archt—May 19, 1906. No. 76712.

The Effect of the California Earthquake on Reinforced Concrete. John B. Leonard. Illustrations of buildings, with facts concerning them, showing the reliability of this material. 2000 w. Eng Rec—May 26, 1906. No. 76956.

The Effect of the Earthquake at Stanford University, Cal. Prof. Charles D. Marx. Gives the report of the examining committee on the condition of the buildings. Ills. 1200 w. Eng Rec—May 12, 1906. No. 76647.

The Recent Earthquake in Central California and the Resulting Fire in San Francisco. J. D. Galloway. An illustrated account of the damage wrought, and the effect on different classes of structures. 2000 w. Eng News—May 10, 1906. No. 76622.

The Saving of the Western Electric Building at San Francisco. Describes the construction of this building which withstood the recent earthquake and fire with very little damage. 1800 w. Eng Rec—May 12, 1906. No. 76649.

Tunnels.

Construction of the Gallitzin Tunnel on the Pennsylvania Railroad. Illustrated detailed description of the construction of this new tunnel for west bound trains. 2400 w. Eng Rec—May 5, 1906. No. 76526.

Recent Tunnel Construction of the Rapid Transit Railroad in Brooklyn. Illustrated description of the section from Court to Clinton St., where the subgrade was from 33 to 52 feet below the surface, and the conditions difficult. 4500 w. Eng Rec—May 12, 1906. No. 76650.

Relining the Allegheny Tunnel, Pennsylvania R. R. Illustrates and describes extensive repairs and the method of carrying them out. 1300 w. Eng Rec—May 12, 1906. No. 76651.

Troubles with East River Tunnels. S. D. V. Burr. Describes the troubles from blowouts, and from distortion in the tubes being placed under the East River at New York, and the methods of overcoming the difficulties. 1200 w. Ir Age—May 24, 1906. No. 76770.

Underpinning.

Underpinning the Marshall Field Building in Chicago. An interesting illustrated description of method of shoring a building while heavy foundations were constructed under it, and under very difficult conditions. 4000 w. Eng Rec—May 5, 1906. No. 76520.

MATERIALS OF CONSTRUCTION.

Asphalt.

The Uses of Natural Asphalt in the Arts. Felix Lindenberg. A brief review of past uses, with a description of some of the more important present uses of natural asphalt. 5000 w. Sci Am Sup—May 5, 1906. No. 76502.

Cement.

A New Magnesium Oxy-Chloride Cementing Material. Thomas W. Capposi. Information concerning this material and its uses. 1100 w. Eng News—May 17, 1906. No. 76676.

British Standard Specification for Cement. The comments of an English engineer on the work and report of the committee which drew up the British Standard Specification for cement. 1000 w. Cement Age—May, 1906. No. 76518.

Problems in Burning Portland Cement with Long Rotary Kilns. Carleton Ellis. A discussion of the "long" kiln and its economies, with remarks on the Eldred system. Ills. 1000 w. Eng News—May 24, 1906. No. 76781.

Clay.

Burnt Clay as the Universal Building Material. F. W. Fitzpatrick. Historical review of the use of this material, urging its value as a fireproof material. Ills. 4000 w. Brick—May, 1906. No. 76585.

Concrete.

Concrete Mixing Machinery. Illustrates and describes a number of interesting concrete mixers of various types. 2500 w. Sci Am—May 12, 1906. No. 76629.

Concrete Mixing Machinery. William L. Larkin. General discussion of machinery for concrete mixing, the defects of the earlier machines, and the types in use at present, and the method of operating. 5000 w. Sci Am Sup—May 26, 1906. No. 76791.

Determining Quantities in Concrete Mixing. Sanford E. Thompson. Presents an average and uniform method for proportioning materials for Portland cement concrete. 900 w. Cement Age—May, 1906. No. 76519.

Concrete Blocks.

Cement Block Architecture. Louis H. Gibson. Gives illustrations of successful work with this material, discussing them and the material used. 2500 w. Munic Engng—May, 1906. No. 76909 C.

Concrete Block Machines. Illustrates and describes types, with remarks on the material and its advantages in fireproof construction. 1800 w. Sci Am—May, 1906. No. 76630.

Corrosion.

The Preservation of Iron and Steel. B. H. Thwaite. Considers the effects of corrosion and discusses methods of preservation. 2000 w. Ir & St Mag—May, 1906. No. 76900 D.

Dynamite.

Proper Methods for Thawing Dynamite. Information from a brochure printed by the DuPont Co., Wilmington, Del. 1100 w. Eng & Min Jour—May 12, 1906. No. 76606.

Plaster.

I. Plaster-Work. George P. Bankart. II. Decorative Plaster Ceilings. Laurence A. Turner. Two papers discussed together. Traces the development of ornamentation in plaster work in the first paper; and deals with the materials used and execution of the work in the second. Ills. 9300 w. Jour Roy Inst of Brit Archts—April 28, 1906. No. 76713 B.

Rigidity.

The Rigidity of Constructive Materials. James E. Howard. Gives diagram showing the moduli of elasticity of different engineering materials, with notes. 1200 w. Eng Rec—May 26, 1906. No. 76960.

Rock.

The Rationale of Rock Crushing. O. H. Howarth. Explains the conditions under which a rock breaks when crushed by a stamp, crusher, or rolls. 4500 w. Mines & Min—May, 1906. No. 76510 C.

Stone.

Manufactured Stone. Charles D. Watson. A review of the progress of cement work in Canada, with an estimate of the value of manufactured stone in its relation to reinforced concrete construction. Ills. 2800 w. Cement Age—May, 1906. No. 76516.

Tension.

Some Tests Bearing on the Design of Tension Members. Edward Godfrey. States a clause in specifications for steelwork and reports tests made of the principle implied, discussing some other things brought out by the investigation. 2200 w. Eng News—May 3, 1906. No. 76473.

Timber Preservation.

New Tie and Timber Preserving Plant of the Atchison, Topeka and Santa Fe Ry. at Somerville, Texas. Describes the creosoting process used, the seasoning, inspecting and marking, the plant, machinery, equipment, etc. Ills. 4500 w. Eng News—May 3, 1906. No. 76474.

MEASUREMENT.

Alignment.

Co-ordinate Geometry Applied to Problems in Railroad Alignment. G. L. Bilderbeck. Reviews some of the fundamental principles showing their application to railroad work. 2000 w. Eng Rec—May 26, 1906. No. 76958.

Leveling.

Experience with the Prism Level on the United States Geological Survey. E. M. Douglas. Illustrates and describes this instrument, giving information of its working and cost. 2000 w. Eng News—May 17, 1906. No. 76678.

The Cséti Mine Leveling Instrument as Modified by Dolezal (Das Gruben-Nivellierinstrument von Cséti und seine Modifikation nach Prof. Dolezal). E. Dolezal. The improvements include the method of supporting the telescope, the graduation of the rod, and details of adjustment. The use of the instrument in the mine is shown. Serial. Part I. 3000 w. Oesterr Zeitschr f Berg u Huttenwesen—April 28, 1906. No. 76828 D.

Maps.

The Use of Freehand Sketching in Preparing a Topographical Map. Prof. Arthur Lakes. Considers what should be shown and the manner of indicating it. Ills. 2500 w. Mines & Min—May, 1906. No. 76514 C.

MUNICIPAL.

Conduits.

Conduit Construction Through Saw Mill Refuse. Illustrated description of unusual conduit construction at the Parke-Davis works in Detroit, Mich. A water pipe, outfall sewer and pipe conduit were all laid in the same trench. 1300 w. Eng Rec—May 5, 1906. No. 76528.

Destructors.

Refuse Destructor Combined with Electric Light Plant at Westmount, P. Q. Describes and illustrates a plant for a town of about 12,000 inhabitants, near Montreal. Gives a test of the destructor and boiler. 3000 w. Eng News—May 24, 1906. No. 76785.

Refuse Destructors. H. Norman Leask. Briefly reviews the history and evolution of types of furnaces, discussing technical points, and reporting tests. 9000 w. Ills. Trans of Inst of Engrs & Shipbldrs in Scotland—March 20, 1906. No. 76696 D.

Sewage.

A German Sewage Disposal Plant. William H. Schladitz. Describes the works at Naumburg on Saale. Also water purification. Ills. 1500 w. Munic Jour & Engr—May 2, 1906. No. 76491 C.

Biological Methods of Sewage Disposal for Farm Houses, Country Estates and Summer Resorts. William Paul Gerhard. An explanation of the principles of the bacterial methods, illustrating their practical application by examples. 5200 w. Met Work—May 5, 1906. No. 76496.

Pasadena Sewer Farm. S. F. Pearson. An illustrated account of a very satisfactory method of sewage disposal, stating some of the obstacles encountered and the success attained. 2000 w. Munic Jour & Engr—May 2, 1906. No. 76489 C.

Sewage Purification for Columbus, Ohio. George A. Johnson. Explains local conditions, the processes tested, and the final conclusions. 3300 w. Munic Jour & Engr—May 2, 1906. No. 76492 C.

The Purification of Municipal Sewage (Städtische Abwasser und seine Reinigung). H. Bredtschneider. A discussion of the chemical and bacterial methods of sewage purification, and the conditions for which each method is applicable. Two articles. 7500 w. Gesundheits Ingenieur—March 17, 31, 1906. No. 76838 each B.

Sewers.

Brooklyn Sewer System. A. J. Provost, Jr. Information concerning the city's experience with vitrified clay and cement pipe. 2200 w. Munic Jour & Engr—May 2, 1906. No. 76490 C.

Concrete and Concrete Block Sewers in St. Joseph, Mo. Illustrated description of new sewers and the extension of main sewers, of plain concrete, reinforced concrete, or concrete blocks, built according to the system controlled by W. C. Parmley. 2000 w. Eng Rec—May 5, 1906. No. 76521.

Reinforced Concrete Pipe Sewers in St. Joseph, Mo. Describes the extension of sewers through land reclaimed on the Missouri River, the pipe used, and the method of laying it. 1200 w. Eng Rec—April 28, 1906. No. 76419.

The Ingersoll Run Sewer at Des Moines, Ia. A. E. Holmes. Illustrated description of the construction of a brick sewer, and of reinforced concrete sewers, explaining the requirements. 800 w. Eng Rec—May 28, 1906. No. 76417.

The Sewerage System of New Orleans. Explains the conditions and the topography of the city and gives an illustrated description of the system. 3500 w. Eng Rec—May 26, 1906. Serial. 1st part. No. 76955.

Street Traffic.

Street Traffic in New York City, 1885 and 1904. Clifford Richardson. Presents in detail data collected in 1904 on ten streets in New York City for the purpose of determining the traffic carried by a number of representative streets at that time; the results are also compared with those obtained by Francis V. Greene, in 1885. 2500 w. Pro Am Soc of Civ Engrs—May, 1906. No. 76932 E.

WATER SUPPLY.

Brooklyn.

Report on the Water Supply of Brooklyn Borough, New York City, for 1905. Interesting information from this report. Shows the pressing need of increasing the supply. 1200 w. Eng News—May 3, 1906. No. 76476.

Distilled Water.

The Economic Production and Uses of Distilled Water. Henry Leffermann. Introductory remarks on the demand for pure water, especially in large cities, and the means of purification, the uses and advantages of distilled water, and an illustrated description of an apparatus for producing such water in quantities. Discussion. 7000 w. Pro Engrs' Club of Phila—April, 1906. No. 76938 D.

Purification.

Device for Cleansing Stored Water. Ilustrates and describes a system, devised by Timothy Lydon, for draining sediment in reservoirs and tanks. 1000 w. Fire & Water—May 12, 1906. No. 76623.

New Water Purification Plant at Paris, Ky. Robert Spurr Weston. Describes a plant consisting of a coagulating basin, aerators, four rapid filters, and a clear water basin, which possesses original features of design. Ills. 2000 w. Eng News—May 3, 1906. No. 76475.

The Purification of Drinking Water in Large Volumes (Reinigung des Wassers in Grösseren Mengen). A. Oelwein. Advocating the use of alum as a coagulant, followed by mechanical filtration. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—April 13, 1906. No. 76820 D.

Reservoirs.

Concreting the Jerome Park Reservoir. Brief illustrated account of the methods used in carrying out this extensive work. 1300 w. Sci Am—May 12, 1906. No. 76628.

The Development and Practical Construction of Valley Reservoirs (Die Geschichtliche Entwicklung, die Zwecke und der Bau der Talsperren). Dr. O. Intzé. A posthumous paper of the late Dr. Intzé giving an exhaustive review of experiences in the construction of artificial storage reservoirs by building masonry dams across valley outlets. Serial. Part I. 7000 w. Zeitschr d Ver Deutscher Ing—May 5, 1906. No. 76805 D.

Stray Currents.

Electrolysis: General Electrical and Lightning Protection. H. W. Spang. Describes the damage caused to water and gas pipes and other underground metal structures, explaining the causes. 2700 w. Am Gas Lgt Jour—May 7, 1906. No. 76505.

WATERWAYS AND HARBORS.

Coast Canal.

To Connect the Rio Grande and the Mississippi. C. S. E. Holland. Map and description of the proposed intercoastal canal connecting the Mississippi River and its tributaries with the coast region of Louisiana and Texas to the mouth of the Rio Grande. 900 w. Mfrs Rec—May 3, 1906. No. 76481.

Coasts.

Coast Erosion and Reclamation. Describes the physical causes at work, the present condition of the portions most seriously attacked, and the possibilities of remunerative protection. 3500 w. Engr, Lond—April 27, 1906. Serial. 1st part. No. 76578 A.

Dredger.

New Dredger for the Clyde. A new and very powerful barge-loading bucket dredger is illustrated and described. 800 w. Engr, Lond—April 27, 1906. No. 76581 A.

Submerged Chain Cable Groynes. R. G. Allanson-Winn. Discusses the force at work along the coasts, especially deep-sea erosion, and the method of protecting the land by the use of the chain cable groyne. 9 plates. 7000 w. Soc of Engrs—March 5, 1906. No. 77009 N.

Emden.

The Harbor Plant at Emden (Die Emdener Hafenanlage). E. Leber. An account of the cranes, cantilevers, conveyors and other mechanical appliances recently installed for the handling of coal and iron at the port of Emden, East Friesland. A good map of the docks, quays and other harbor improvements is given. 4000 w. 1 plate. Stahl u Eisen—May 1, 1906. No. 76809 D.

Genoa.

Extension of the Port of Genoa. Plan and description of improvements in progress. 2200 w. Engr, Lond—May 11, 1906. No. 76765 A.

Panama.

A Novel Plan for Excavating the Culebra Cut. Fremont Hill. An illustrated perspective sketch of the method suggested, which proposes the driving of a three-track tunnel at an elevation just above the surface of the natural water courses, with shafts at intervals, and Lidgerwood traveling cableway excavators. 2000 w. Eng News—May 17, 1906. No. 76677.

Machinery for the Panama Canal—Old and New. Fullerton L. Waldo. An illustrated account of the old machinery left by the French, and the American revival and newly installed appliances. 2500 w. Engineering Magazine—June, 1906. No. 76873 B.

Present Conditions on the Panama Canal Works. T. P. Shonts. Condensed from a special report made by the chairman of the Isthmian Canal Commission to the Secretary of War. 2200 w. Eng News—May 17, 1906. No. 76681.

Statement of Hon. William H. Taft, Secretary of War, Before the Committee on Interoceanic Canals of the United States Senate. Portions of this statement, with editorial comment. 14700 w. Eng News—May 10, 1906. No. 76619.

The Administration View of Panama Canal Affairs. Extracts from the statement of Secretary Taft before the Senate Committee on Interoceanic Canals. 6500 w. Eng Rec—April 28, 1906. No. 76420.

The Majority Report of the Senate Committee on the Type of the Panama Canal. Gives the portions of the report of most interest, the locks and dams, risk in construction, earthquakes, and cost. 4500 w. Eng News—May 24, 1906. No. 76783.

The Panama Canal Under Control of the United States. Henry L. Abbot. Gives a review of the work of the Commission appointed Feb. 9, 1904, and the reorganization of the commission in

April, 1905. 4000 w. Harvard Engng Jour—April, 1906. No. 76694 D.

River Improvement.

Notes on the Regulation of Tidal Rivers (Bemerkungen Zu der Regulierumgswerken auf Tideströmen). A. v. Horn. Discussing especially the construction of embankments, levees, and jetties, for the maintenance of channels in streams subject to the ebb and flow of tides. 3000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—April 28, 1906. No. 76835 D.

The Improvement of the Tennessee River and Power Installation of the Chattanooga and Tennessee River Power Company at Hale's Bar, Tenn. Thomas E. Murray. Describes work undertaken to improve the navigation of the river, and also applied to the development of electrical energy. Ills. 6500 w. Am Soc of Mech Engrs. No. 097—May, 1906. No. 76759 C.

The Rate of Filling the Salton Sink Basin by the Diversion of the Colorado River. Maps and report of the difficulties encountered in California in connection with an irrigation project, and the attempts to remedy the trouble. 1000 w. Eng News—May 10, 1906. No. 76618.

Ship Canal.

The Proposed Norwich and Yarmouth Ship Canal. Map and description of a scheme to build a ship canal in England, with a statement of the advantages expected. 2500 w. Engr, Lond—May 18, 1906. No. 77018 A.

Vienna.

The Improved Winter Harbor at Freudenau (Der Schutz und Winterhafen in der Freudenau). Illustrating and describing the improved docks and harbor works at Freudenau on the Danube, at Vienna. 4000 w. 4 plates. Oesterr Wochenschr f d Oeffent Baudienst—

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The Last Link of the All-American Pacific Cable. Lewis G. Martin. An illustrated account of the laying of an underground cable to connect the Manila-Shanghai submarine cable with the cable office in Shanghai. 1800 w. Elec Rev, N Y—May 19, 1906. No. 76724.

Cable Steamer.

See Marine and Naval Engineering.

Relay.

A Telephone Relay. John Trowbridge. Reviews the development of the telephonic relay, considering the principles involved in its construction, and describes the relay invented by the writer. Ills. 3000 w. Am Jour of Sci—May, 1906. No. 76691 D.

Signaling.

Apparatus for Electric Signaling and Firing for Mortar Batteries. William C. Davis. States the important requisites for signaling and for firing apparatus, and describes the proposed apparatus for electric signaling and firing for mortar batteries. Ills. 4000 w. Jour U S Art—March, 1906. No. 76793 D.

Space Telegraphy.

Atmospheric Electricity and Trees. Prof. A. G. McAdie. An illustrated discussion of the effect of sunshine on transmission of wireless messages, the behavior of trees during thunder storms, wireless experiments with trees, etc. 3800 w. Elec Wld—April 28, 1906. No. 76590.

Massie Wireless Telegraph System. Illustrated description of this system as used at the present time. 2000 w. Elec Wld—April 28, 1906. No. 76589.

On a Method of Obtaining Continuous Currents from a Magnetic Detector of the Self-Restoring Type. L. H. Walter. Read before the Royal Soc. Describes a method by which the author has succeeded in obtaining continuous unidirectional currents from a detector in which the energy available is derived in part from the external field. 1500 w. Elect'n, Lond—May 18, 1906. No. 76992 A.

On Methods Whereby the Radiation of Electric Waves May Be Mainly Confined to Certain Directions, and Whereby the Receptivity of a Receiver May Be Restricted to Electric Waves Emanating from Certain Directions. G. Marconi. Read before the Royal Soc. Reports results obtained by substituting a horizontal direct-excited air wire directed toward the receiving station, at a comparatively small distance above the surface. Diagrams. 2000 w. Electn, Lond—May 4, 1906. No. 76663 A.

Wireless Telegraphy. Reginald A. Fessenden. Gives a brief description of some of the work done by the writer relative to the determination of laws governing the propagation of wireless disturbances, with some new facts hitherto unpublished. 3000 w. Elec Rev, Lond—May 11, 1906. Serial. 1st part. No. 76755 A.

Wireless Telegraphy from the Andaman Islands to the Mainland of Burma. Copy of a report relating to this installation, with map showing the position. 2500 w. Elect'n, Lond—April 27, 1906. No. 76563 A.

Telephony.

Experiments on the Inductive Vienna-Innsbruck Telephone Line. Describes a series of interesting tests carried out on a line "loaded" inductively according to the Pupin system. 700 w. Elect'n, Lond —May 4, 1906. No. 76662 A.

Standardization of Methods and Appliances in Telephony. Frank R. McBerty. A discussion of the considerations tending toward the standardizing of appliances, and also some of the disadvantages. General discussion follows. 6800 w. Jour W Soc of Engrs—April, 1906. No. 76931 D.

The Lorimer Automatic Telephone. An illustrated explanation of the action and advantages of a new invention by two Americans, now on trial at Paris. 1600 w. Sci Am—May 26, 1906. No. 76787.

The Telephone System of Today. C. J. H. Woodbury. Remarks on the early attempts at transmission of sound, the telephone instrument, transmitter, administration of the telephone system, lines, switchboard, uses, rates, etc. Discussion. 14000 w. Pro Engrs' Club of Phila—April, 1906. No. 76937 D.

Testing.

American Practice in the Detection of Faults in Telephone Lines (Gebräuchliche Amerikanische Verfahren zur Bestimmung von Fehlern in Fernsprechleitungen). Max Freimark. Describing methods of testing and localizing faults by the use of Wheatstone bridge, using the methods of Murray and Varley. 3000 w. Elektrotech Zeitschr—April 19, 1906. No. 76850 B.

DISTRIBUTION.

Accumulators.

Storage Batteries for Polyphase Currents (Anwendung von Pufferbatterien bei Drehstrom). L. Schroeder. Describing an improved arrangement of motor-generator with special shunt regulator, acting on the field of the direct current portion of the motor-generator. 3000 w. Elektrotech u Maschinenbau—April 15, 1906. No. 76846 D.

Cables.

Rubber Insulated Cables Without Lead. James S. McLean. Gives the writer's observations on the installation of non-leaded rubber-insulated cable, with reasons why the lead sheath is needed, and the care that should be given it. 1200 w. Elec Wld—May 26, 1906. No. 76978.

Connections.

Some Electrical Puzzlers. E. S. Lincoln. Explains puzzling cases occurring in the writer's experience. 1400 w. Power—June, 1906. No. 76749 C.

Faults.

Causes and Prevention of Faults on Direct-Current Networks. F. Fernie. Observations referring to a direct-current three-wire network, with the neutral wire earthed at one place, and 460 volts between the outer wires. 2800 w. Elect'n, Lond—May 11, 1906. No. 76756 A.

Regulation.

The Regulation of the Pressure of Discharge of Lighting Batteries. Ernest P. Hollis and E. R. Alexander. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. The booster method, and the regulating cell method are considered and compared. 2000 w. Elec Engr. Lond —May 18, 1906. Serial. 1st part. No. 76988 A.

Rules.

Board of Trade Extra-High-Pressure Regulations. A copy of recently issued regulations under the Electric Lighting Acts, with editorial comment. 3000 w. Elect'n, Lond—April 27, 1906. No. 76565 A.

Sub-Stations.

Some Interesting Features in the Design of a 3000 Kilowatt Sub-Station. S. J. Lisberger. Describes interesting features of sub-station No. 2, Oakland, Cal. Ills. 2700 w. Wis Engr—June, 1906. No. 76697 D.

The Boston Edison Company's Natick Station. Illustrates and describes interesting features of a station which supplies light and power to some seven or eight towns of Massachusetts, near Boston. 1200 w. Elec Wld—April 28, 1906. No. 76591.

Transformers.

Switching Arrangements for the Reduction of Losses in Single-Phase and Polyphase Transformers (Schaltungsanordnungen zur Vermeidung bezw. Verringerung der Leer laufsarbeit bei Ein und Mehrphasen Wechselstrom-Transformatoren). J. Schmidt. Discussing automatic switch devices for the control of current for transformers when running under light or no load. Serial. Part 1. 2500 w. Elektrotech u Maschinenbau—May 6, 1906. No. 76849 D.

The Theory of Shop Methods of Testing Single and Polyphase Transformers. J. W. Rogers. Reviews facts connected with the working and the losses occurring in a transformer, and describes the tests generally carried out, giving diagrams. 2000 w. Elec Engr, Lond—May 4, 1906. Serial. 1st part. No. 76661 A.

Voltage Regulation in Transformer Stations (Spannungsregelung in Transformator Stationen). Heinrich Hinden. With graphical diagrams discussing the Tirrell regulator and the use of boosters for the maintenance of voltage. Two articles. 7500 w. Elektrotech Zeitschr—April 26, May 3, 1906. No. 76853 each B.

Wiring.

Notes on Wiring with Lead-Covered Rubber Insulated Wire. Presents the advantages of this system, comparing with other systems in use. Ills. 1500 w. Elec Rev, Lond—April 20, 1906. No. 76437 A.

ELECTRO-CHEMISTRY.

Anodes.

Truswell's Anode Mold. R. Truswell. Illustrated description of a new mold developed for the purpose of casting anodes. 700 w. Engr & Min Jour—May 5, 1906. No. 76547.

Electric Furnace.

The Electric Furnace: Its Evolution, Theory and Practice. Alfred Stansfield. Gives the history of the electric furnace, with general description and classification, its efficiency, cost, design, construction, operation, uses. etc. Ills. 3500 w. Can Engr—May, 1906. Serial. 1st part. No. 76624.

Industries.

The Electrochemical and Electrometallurgical Industries in 1906. John B. C. Kershaw. Gives details of the present position in these industries, with interesting illustrations. 5500 w. Cassier's Mag—May, 1906. No. 76484 B.

Laboratory.

Laboratory of Applied Electro-Chemistry at Columbia University. Prof. Samuel A. Tucker. Illustrated description of laboratory for the study of practical electro-chemistry, and for research work and some of the appliances used. 1500 w. Elec-Chem & Met Ind—May, 1906. No. 76427 C.

Scrap.

Electrical Recovery of Scrap Metal. George E. Walsh. Information concerning the increasing use of the electric current for recovery works. 2200 w. Min Wld—May 26, 1906. No. 76980.

Smelting.

Electric Lead Smelting. Anson G. Betts. A report of experiments with the Betts-Valentine process, describing the process and giving results. Also editorial. 6000 w. Elec Chem & Met Ind—May, 1906. No. 76426 C.

ELECTRO-PHYSICS.

Flux Distribution.

Notes on the Distribution of the Magnetic Flux in Direct-Current Machines with Commutating Poles. Dr. R. Pohl. An explanation of the distribution of the commutating flux considering unloaded machines and armature reaction. Ills. 2500 w. Elec Engr, Lond—April 20, 1906. No. 76435 A.

Induction.

Self Induction or Armature Reaction (Selbstinduktion oder Ankerruckwirkung?) Hermann Zipp. A discussion of the theory of Peukert, considering the secondary circuits of continuous and alternating currents. 2000 w. Elektrotech Zeitschr—May 3, 1906. No. 76856 B.

Insulation.

The Influence of Polish upon the Insulating Properties of Wood (Einfluss der Politur auf die Isolierenden Eigenschaften von Holz). Karl Wernicke. A discussion of experiments, showing that polishing does not materially affect the insulating properties of wood. 1500 w. Elektrotech Zeitschr—May 17, 1906. No. 76860 B.

Resonance.

A Resume of Electrical Resonance. Frank F. Fowle. Describes the occurrence of resonance and the conditions that cause it, its uses and dangers. 1500 w. Elec Rev, N Y—May 19, 1906. Serial. 1st part. No. 76723.

GENERATING STATIONS.

Armatures.

Putting on a Direct-driven Generator Armature. H. L. Strong. Explains the writer's experience in the first attempt to force on the armature of a small-sized generator. 900 w. Power—June, 1906. No. 76748 C.

Boosters.

Notes on Booster Developments. A. H. Kelsall. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Explains the action of the reversible booster, and the devices for making the booster changes automatic and its uses. 2400 w. Elect'n, Lond—April 20, 1906. No. 76440 A.

Notes on Booster Developments. A H. Kelsall. Reviews a paper by this author read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. Refers to old and new methods, and especially considers the Lancashire "automatic booster." 1500 w. Elec Engr, Lond—May 18, 1906. No. 76987 A.

Commutators.

Mechanical design of Commutators for Direct-Current Generators. R. Livingstone. The present number states the requirements of a satisfactory commutator, discussing each briefly, and explaining the causes of stress in different parts of a commutator. 1000 w. Elect'n, Lond—May 18, 1906. Serial. 1st part. No. 76991 A.

Converters.

Shunt and Compound-Wound Synchronous Converters for Railway Work. W. L. Waters. Discusses and compares the advantages and disadvantages of the two methods of excitation. Considers the best system for general work is to have shunt-wound converters, standard transformers, and no reactance coils. 1600 w. Pro Am Inst of Elec Engrs—May, 1906. No. 76941 D.

Synchronous Converters Versus Motor Generators. Clarence P. Fowler. A comparison of their efficiency, floor space and cost, inherent regulation and voltage control, overload capacity, methods of starting, hunting, power factor, frequency, and reversibility. 3300 w. Elec Wld—May 26, 1906. No. 76977.

Three to Six Transformation and Connections to Rotary Converters. Guy J. Reynolds. Explains the three ways of transforming from three to six-phase current. 600 w. Elec Wld—May 19, 1906. No. 76742.

Economy.

The Effect of Day Load on Central Station Economy. J. P. Jones. A symposium presented before the convention of the Iowa Electrical Association. 4000 w. Elec Rev, N Y—May 12, 1906. No. 76601.

Efficiency.

Discussion on "Power Plant Economics," at Pittsburg, Pa., February 13, 1906. Discussion of Henry G. Stott's paper on this subject. 5400 w. Pro Am Inst of Elec Engrs—May, 1906. No. 76942 D.

Generating Set.

The New Steam-Dynamo Group at the Moabit Station in Berlin (Die Neuen Dampfdynamogruppen der Zentrale Moabit in Berlin). Illustrating especially the 6000 horse-power horizontal triple-expansion steam engines by Sulzer Bros. with direct-connected A. E. G. alternators. 1200 w. 2 plates. Schweiz Bauzeitung—May 5, 1906. No. 76832 B.

Generators.

The Design of Electric Generators. W. O. Horsnaill. On the use of comparative formulæ in the mechanical design of electric generators. 2500 w. Engng—May 11, 1906. No. 76761 A.

Three-Wire Direct-Current Generators. A. H. McIntire. Based on a lecture by W. A. Dick. Illustrates and describes these machines and their working. 1000 w. Elec Jour—May, 1906. No. 76706.

Governors.

Electromagnetic Control of Governors. Harry R. Speyer. Explains the action of the electro-magnetic control of the governor of the steam engine which drives the dynamos. Ills. 1100 w. Elec Engr, Lond—April 20, 1906. No. 76436 A.

Hydro-Electric.

Hydro-electric Plant of the City of Drammen, Norway. Franz Koester. Illustrated, detailed description of an installation including a generating station, a step-up transformer system, a long-distance high-tension transmission line, step-down transformer sub-stations and low-tension distributing system. 2500 w. Elec Rev, N Y—May 12, 1906. No. 76600.

The Electric Station at Wangen, on the Aar (Das Elektrizitätswerk Wangen on der Aare). K. Meyer. An illustrated description of the new power plant at Wangen, Switzerland, where 4,500 horse power is developed from the Aar, for distribution in the Cantons of Solothurn and Bern, and in German Alsace. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—May 12, 1906. No. 76815 D.

Hydraulic Features of the Plant of the Pike's Peak Hydro-Electric Co., Manitou, Colo. Plan and section of the station, with description and illustrations. 2500 w. Eng Rec—May 19, 1906. No. 76734.

Plant of the Pike's Peak Hydro-Electric Company. Illustrated detailed description of a plant at Manitou, Colorado, which employs the highest head of water yet attempted, the static head being 2417 ft., and other features of interest. 4000 w. Elec Wld—May 26, 1906. No. 76975.

The Hydro-Electric Developments at Trenton Falls, N. Y. Illustrated description of an interesting electrical development in Central New York. Also editorial. 2000 w. Elec Wld—May 19, 1906. No. 76740.

Installation.

Practical Installation of Electrical Apparatus. Thomas W. Poppe. Gives a method applicable to any size of generator likely to be handled by the ordinary central station. Ills. 800 w. Elec Wld—May 5, 1906. No. 76551.

Newcastle.

The Newcastle Electric Supply Company. 2500 w. Elec Engr, Lond—May 11, 1906. No. 76754 A.

Production.

Central Station Light, Heat and Power Principles. Newton Harrison. Discusses things of importance in the production of electricity on a large scale. 1700 w. Cent Sta—May, 1906. No. 76597.

Scotland.

Electric Light and Power in the Highlands. W. B. Esson. An illustrated description of the plant furnishing light and power to the towns of Dingwall and Strathpeffer Spa. 2500 w. Elec Mag—April 24, 1906. No. 76482 A.

Testing.

A Scheme for Testing the Efficiency of Electrical Power Plants and for Keeping the Necessary Records. Wilmot E. Ellis. Outlines the scheme of tests and records that has been in operation in the Artillery District of Portland since Dec. 5, 1905, giving blanks used. 2800 w. Jour U S Art—March, 1906. No. 76792 D.

Turbine Plant.

Turbine Plant of the Oshkosh Gas Light Co. Illustrated description of a plant for supplying light and power to a city of 30,000 inhabitants. 1600 w. Engr, U S A—May 1, 1906. No. 76465 C.

Ventilation.

The Ventilation of Turbo-dynamos (Ventilation von Turbo-dynamos). F. Niethammer. Discussing the arrangement of axial air inlets and radial discharge passages in the armatures of high-speed dynamos for direct connection to steam turbines. 3500 w Elektrotech u Maschinenbau—April 22, 1906. No. 76847 D.

LIGHTING.

Arc Lamps.

A New Form of Electric Arc Lamp (Ueber eine Neue Form einer Elektrische Bogenlampe). E. Stadelmann. A mass of fire-clay or other incandescent material is placed adjacent to the arc, and when heated, becomes a partial conductor of incandescent effect. 1500 w. Elektrotech Zeitschr—May 3, 1906. No. 76855 B.

Arc Lighting. R. H. Henderson. Considers details of arc lamps, their operation and maintenance, classification, etc. 3000 w. Elec Jour—May, 1906. No. 76703.

Long Flame Arc Lamps. Leonard Andrews. Read before the Inst. of Elec. Engrs. Considers improvements effected, showing that increased efficiency is directly or indirectly due to increased length of arc. 2200 w. Elect'n, Lond—April 27, 1906. Serial. 1st part. No. 76564 A.

Church Lighting.

Notes on the Lighting of Churches. Edwin R. Weeks. Discusses the requisites in church lighting, the systems of electric lighting for interiors, illustrating by an application. Ills. 1700 w. Pro Am Inst of Elec Engrs—May, 1906. No. 76940 D

Desk Lighting.

The Lighting of Desks. J. R. Cravath and V. R. Lansingh. States the requirements and considers a number of illustrations showing prevailing methods. 1000 w. Elec Wld—May 5, 1906. No. 76550.

India.

The Electric Lighting of Lashkar City, Gwalior, Central India. Illustrates and describes the system adopted, which is a three-wire continuous current with 450 volts across the outers. 1000 w. Elec Rev, Lond—April, 27, 1906. No. 76561 A.

Intensity.

The Distribution of Illumination in the Neighborhood of Two Lamps. J. R. Benton. Explains how to ascertain the maximum intensity of illumination at any point, and how to find the proper candlepower to produce a given intensity of illumination. 2000 w. Elec Wld—May 5, 1906. No. 76549.

Mercury Arc.

Observations on the Mercury Arc and Some Resultant Problems in Photometry. C. Orme Bastian. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Shows that the mercury arc lamps will prove useful in combating other illuminants, and gives an interesting study of its luminosity. 3500 w. Elect'n, Lond—May 11, 1906. No. 76758 A.

The Production of Red Light in the Mercury Vapor Lamp. (Ueber die Erzeugung Roten Lichtes in der Quecksilber lampe). E. Gehrcke and O. von Baeyer. The color of the light is improved by adding zinc to the mercury; also a small amount of sodium to correct the yellow rays. 600 w. Elektrotech Zeitschr—April 19, 1906. No. 76852 B.

Nernst.

Rare Earths and Electric Illuminants. Murray C. Beebe. Discusses the properties of some of the rare earth oxides, various experimental tests, and experiments with the Nernst glower. 6000 w. Wis Engr—June, 1906. No. 76699 D.

Rates.

Equitable Rates in Relation to Rate Regulation. George M'Lean. Read before the Iowa Elec. Assn. An explanation of the lighting corporations' position, and a discussion of rate regulation. 2500 w. Elec Rev, N Y—May 12, 1906. No. 76602.

Residence Lighting.

Residence Lighting and Other Central Station Work at Wabash, Ind. An illustrated article describing the plant in a town of 9,000 inhabitants, where residence lighting forms a large proportion of the business. 2000 w. Elec Wld—May 12, 1906. No. 76652.

Theatre Lighting.

Electricity at the New York Hippodrome. An illustrated article showing the extent to which electricity is used in this amusement building, for utilitarian, decorative, and advertising purposes. 3500 w. Elec Wld—May 5, 1906. No. 75548.

MEASUREMENT.

Photometers.

A Practical Installation of the Ulbricht Spherical Photometer (Eine Ausführungs fonn des Ulbrichtschen Kugelphotometers). Dr. M. Corsepius. Describing the apparatus at the Cologne Polytechnic. The sphere is two meters in diameter. Data and results of a number of tests are given. 3500 w. Elektrotech Zeitschr —May 17, 1906. No. 76859 B.

The Determination of the Hemispherical Intensity of Luminous Bodies (Zur Berechnung der Hemisphärischen Intensität Körperlicher Lichtquellen). Dr. H. Heimann. Deriving methods of computing the hemispherical intensity from measurements made of several zones. 3500

w. Elektrotech Zeitschr—April 19, 1906. No. 76851 B.

Symbols.

Standard Electrical Symbols (Einheitliche Formelzeichen). K. Strecker. A report to the *Elektrotechnischer Verein,* suggesting an elaborate system of standard symbols for physical and electrical magnitudes. 10000 w. Elektrotech Zeitschr—May 10, 1906. No. 76857 B.

Temperature.

Measurement of Temperature by Electrical Means. Edwin F. Northrup. Considers electrical methods of measuring temperature, electrical resistance thermometry, construction of resistance thermometers, slide-wire bridge methods, use of dial or decade Wheatstone bridges, etc. Ills. 770 w. Pro Am Inst of Elec Engrs—May, 1906. No. 76939 D.

Transformers.

The Testing of Transformers and Transformer Iron. D. K. Morris and G. A. Lister. Abstract of a paper read before the Birmingham Sec. of the Inst. of Elec. Engrs. Describes a diagram found useful in transformer problems, and proposes a standard test involving one set of connections, three instruments, and the normal supply. 3200 w. Elect'n Lond—April 27, 1906. No. 76566 A.

Voltage.

The Estimation of the Reactance Voltage of Continuous Current Dynamos. H. M. Hobart. Describes a method having the merits of simplicity of the formula and saving in time. 700 w. Elect'n, Lond—April 20, 1906. No. 76439 A.

Weak Currents.

An Improved Measuring Appliance for Weak Alternating Currents (Ein Neues Messgerät für Schwache Wechselströme) W. Voege. The current is measured by the rise in temperature of a platinum wire enclosed in a vacuum bulb, using a thermo-electric pile and mirror galvanometer. 1800 w. Elektrotech Zeitschr—May 17,1906. No. 76858 B.

MOTORS.

Direct-Current.

Care of Direct-Current Motors. John Howatt. Calls attention to the troubles due to dirt and dampness, the causes of sparking, etc. 2000 w. Power—June, 1906. No. 76750 C.

Induction Motor.

Simple Circular Current Locus of the Induction Motor. A. S. M'Allister. Discusses the use of the simple circular locus of the primary and secondary currents of the motor for determining the complete performance of the machine. 1300 w. Elec Wld—May 26, 1906. No. 76976.

Interpole.

The Auxiliary-Pole Type of Motor. J. M. Hipple. The effect of the auxiliary field in producing sparkless commutation, the efficiency of the auxiliary-pole motor, etc., are discussed. 1200 w. Elec Jour—May, 1906. No. 76704.

Tests of an Interpole Railway Motor G. Herbert Condict. Gives characteristic curves of a 35 H. P. interpole motor showing its remarkable performance when operated under weak field conditions. Also the possibilities of control. 700 w. St Ry Jour—May 26, 1906. No. 76964 C.

Single-Phase.

The Action of Single-Phase Collector Motors with Reference to Short-Circuiting under the Brushes (Das Verhalten des Einphasen-Kollektormotors unter Berücksichtigung der Kurzschlussstrome unter den Bürsten). Dr. Max Breslauer. An elaborate discussion of the single-phase motor, using the analysis of the circle diagram. 8000 w. Elektrotech Zeitschr—April 26, 1906. No. 76854 B.

Windings.

The Calculation of Polyphase Induction Motor Windings. F. T. Chapman. Indicates a rapid method of determining approximately the most suitable winding from the standpoint of the power factor and overload capacity, for a motor whose mechanical dimensions are already fixed. 600 w. Elect'n, Lond—May 18, 1906. No. 76990 A.

TRANSMISSION.

Cables.

Admissible Limits of Pressure for Armored Cables (Limites Admissibles pour les Tensions de Service des Cables Armés). M. de Marchena. A review of practical experiences showing the successful use of pressures up to 22,000 volts. 7000 w. Bull Soc Int des Electriciens—April, 1906. No. 76863 G.

Lightning Arresters.

Earthing Resistances for Lightning Protectors (Erdleitungswiderstände bei Blitzschutzvorrichtungen). Gustav Bernischke. Discussing the advantages of carborundum as a material for resistances, with practical details as to its use in connection with lightning arresters. Discussion. 6000 w. Elektrotech Zeitschr—May 17, 1906. No. 76862 B.

Superposition.

The Application of the Principle of Superposition to the Transmission of Alternating Currents over a Long Line (Application du Principe de la Superposition à la Transmission des Courants Alternatifs sur une Longue Ligne). A. Blondel. Deriving a graphical method, giving a form of diagram for practical use in computing the pressure and current at the end of the line. 1200 w. Comptes Rendus—May 7, 1906. No. 76829 D.

INDUSTRIAL ECONOMY.

Address.

The Unifying of the Republic. Silas G. Comfort. President's address. An interesting review of engineering development and achievement during the last thirty years as introductory to a consideration of the advancement made from 1800 to about 1830, describing conditions of one hundred years ago, the engineering achievements, etc. 7800 w. Pro Engr's Club of Phila—April, 1906. No. 76935 D.

American Industries.

Personal Reminiscences of the Past Half-Century. James Christie. Remarks on the industrial conditions in the United States, about fifty years ago. Deals with transportation, iron manufacture, ship and boat building, mining, agriculture, etc. 8500 w. Pro Engr's Club of Phila—April, 1906. No. 76936 D.

Classification.

Classification of Engineering Expenditures. F. H. Newell. Discusses the object and methods of classification. 3000 w. Eng Rec—April 28, 1906. No. 76413.

Development.

Industrial Development. Explains a scheme in connection with the development of the North-Eastern districts, England, with the object of establishing new industries, where rates are low and electric power cheap, and where railway and water facilities are abundant. Maps. 1500 w. Elec Rev, Lond—April 27, 1906. No. 76560 A.

Education.

Education and Training of Engineers. The essential part of the report of the Committee on the Education of Engineers, appointed by the Institution of Civil Engineers. Also editorial. 4500 w. Engr, Lond—April 27, 1906. No. 76579 A.

Fire Losses.

Fire Losses in the United States. A Grave National Question. Joseph K. Freitag. A discussion of the lessons of the San Francisco disaster, showing the general lack of real fire-proof construction throughout the country. 3500 w. Engineering Magazine—June, 1906. No. 76871 B.

Government Work.

An Army View of American Government Engineering. Maj. W. L. Sibert. An advocacy of government control of engineering work and of its practical efficiency. 2500 w. Engineering Magazine—June, 1906. No. 76874 B.

Inventory.

Plant Inventory—Importance. Value and Method of Keeping a Going Inventory. F. B. Johnson. Gives forms of card records and shows its usefulness and value. 1200 w. Am Mach—Vol. 29. No. 21. No. 76771.

Italy.

Italian Industries. On the rapid commercial development of Italy, and the causes. The present article discusses the utilization of the abundance of water. Ills. 3500 w. Engr, Lond—April 20, 1906. Serial. 1st part. No. 76449 A.

Labor.

Railway Servants Hours of Labor. Discusses the question as related to England. 2300 w. Engr, Lond—May 11, 1906. No. 76767 A.

Piece Work.

Piece Work. J. Bertram. Explains a piece-work plan in which the price is fixed per piece. 1200 w. Am Mach—Vol. 29. No. 18. No. 76470.

Public Utilities.

A Bill Providing for Government Development and Ownership of Water Power in Ontario. A discussion of a bill representing one of the most extensive experiments in public ownership of utilities ever tried. 1000 w. Eng News—May 24, 1906. No. 76777.

Transportation.

Transportation, and Its Relation to Manufacture. Jno. J. Baulch. Shows their dependence upon each other, and considers especially conditions at St. Louis. Discussion. 11600 w. Pro St Louis Ry Club—April 13, 1906. No. 76692.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trial Performance of the United States Battleship Louisiana. A. F. Bowen and H. B. Gregory. Gives detailed description of the vessel, its armor, ordnance, equipment, etc., with report of trials. Also editorial. 7800 w. Int Marine Engng—May, 1906. No. 76421 C.

The Japanese Battleship "Katori." Fully illustrated article giving detailed description of the ship, its armor, armament, etc., with report of steam, trials. 5700 w. Engng—May 11, 1906. No. 76762 A.

We supply copies of these articles. See page 637.

Boilers.

See Mechanical Engineering, Steam Engineering.

Cable Steamer.

Twin-Screw Cable Steamer Grand Duke of Oldenburg (Doppelschrauben Kabeldampfer Grossherzog von Oldenburg). General description and details of cable-laying steamer built by Schichau for the North German Marine Cable Company. There are three cable tanks of 850 cubic metres capacity. 2000 w. 1 plate. Schiffbau—May 9, 1906. No. 76833 D.

Capstans.

English and American Capstans and Electric Winches. Frank C. Perkins. Illustrates and describes types used. 1000 w. Int Marine Engng—May, 1906. No. 76423 C.

Cruiser.

French Armored Cruiser. Ernest Renan. Illustrated detailed description of this recently launched vessel, the largest and most powerful yet laid down in France. 1700 w. Engr, Lond—April 20, 1906. No. 76452 A.

Curiosities.

Curiosities of Naval Architecture—Round Ships and Globular Vessels. C. Field. Brief illustrated descriptions of vessels of these types constructed or proposed. 2500 w. Sci Am—May 5, 1906. No. 76499.

Engines.

See Mechanical Engineering, Combustion Motors.

See Mechanical Engineering, Steam Engineering.

Experimental Tank.

Ship-Model Experimental Tank at the Clydebank Shipyard. Reviews results of tank work, and gives an illustrated detailed description of this tank at Clydebank. 6000 w. Engng—April 27, 1906. No. 76570 A.

Freeboards.

Notes on the Freeboard Rules. J. Foster King. Read before the Inst. of Naval Archts. Notes upon an examination of the German Rules for Freeboard, and their bearing upon the general question. 4000 w. Engng—April 27, 1906. No. 76576 A.

Launch.

A Forty-Foot Cruising Launch. John Q. Walton. Description, with illustrations, of a recently completed vessel. 1300 w. Int Marine Engng—June, 1906. No. 76775 C.

Liner.

The Holland-America Liner Nieuw Amsterdam. Illustrated detailed description of this fine vessel, recently placed in service between Rotterdam and New York. 2800 w. Int Marine Engng—June, 1906. No. 76772 C.

Marine Railway.

The Overland Transport of Vessels by Marine Railway (Bemerkungen uber den Trockentransport bei Schiffseisen bahnen). E. Wehrenfennig. With illustrations of a type of marine railway intended as a substitute for canal service, using inclined planes in place of locks. 1800 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April 21, 1906. No. 76834 D.

Motor Boats.

A Paraffin Motor Launch. Illustrated description of a small launch built for the Soudan Government, intended for service at Khartoum. 700 w. Engr, Lond—May 18, 1906. No. 77020 A.

High-Speed Motor-Boats. James A. Smith. Read before the Inst. of Nav. Archts. Discusses the design and construction, mainly of high-speed launches with internal-combustion motors. Ills. 3500 w. Engng—April 20, 1906. No. 76454 A.

On Steering and Manœuvering of Power Boats. Norman L. Skeene. A study of the lateral plane, the action of the propeller, and the action of the rudder. Diagrams. 1700 w. Rudder—May, 1906. No. 76588 C.

Naval Machinery.

Standardization of Naval Machinery. Deals with the standardization of the machinery of H. M. armored cruiser "Duke or Edinburgh," reporting trials. Ills. 3800 w. Engng—May 4, 1906. Serial. 1st part. No. 76667 A.

Naval Training.

A New Scheme of Naval Training. J. A. Ewing. Lecture at the Royal Naval College, Portsmouth. Discusses the new scheme recently inaugurated in England, giving an account of its very satisfactory development and of the training at the colleges at Osborne. 4000 w. Engr, Lond—May 18, 1906. Serial. 1st part. No. 77022 A.

Navies.

Comparison of the French and German Navies. J. Peltier. Gives a comparison from the report of the French Minister of Marine, with a supplement showing how the American navy compares with the other two. 1800 w. Int Marine Engng—June, 1906. No. 76773 C.

Navigation.

Shaping the Course. Clarence E Long. Describes the manner of safely conducing the navigation of any vessel from port to port. 4800 w. Marine Rev—May 17, 1906. Serial. 1st part. No. 76714.

Ore Carrier.

The Ore-Carrying Steamer Narvik (Der Erzdampfer Narvik). H Herner. A fully illustrated description of a 6000 ton ore carrier on the Doxford turret model, built by Krupp for the transport of the Lapland iron ores from Narvik to Rotterdam. 1800 w. Zeitschr d Ver Deutscher Ing—May 5, 1906. No. 76807 D.

Propellers.

The Molding of Propellers. Outlines the two general methods of molding and casting the screw propeller—the use of the pattern and that of the sweeps. Ills. 4000 w. Int Marine Engng—76424 C.

Reconstruction.

Lengthening of the Steamer Hamilton. Alexander Wills. Illustrated description of this method of increasing the carrying capacity of a ship of the Old Dominion Steamship Co. 2000 w. Int Marine Engng—June, 1906. No. 76774 C.

River Steamer.

The Hendrick Hudson. Illustrated detailed description of this recently launched vessel, said to be the largest river steamer in the world. 3300 w. Int Marine Engng—May, 1906. No. 76425 C.

Shipyard.

Fore River Ship Building Company's Yard. An illustrated description of this modern yard, near Boston, with special reference to its electrical equipment. 2500 w. Marine Rev—May 3, 1906. No. 76515.

Signalling.

Submarine Signalling by Means of Sound. J B. Millet. An account of the experiments in this field, and the invention as used and its operation. Also letters bearing testimony of its value and aid to navigation. Discussion. Ills. 5000 w. Jour Soc of Arts—May 4, 1906. No. 76653 A.

Stability.

Stability Calculations by Planimeter. R. E. Anderson. Discusses a proposed method which requires a planimeter of the least expensive type, and is based on the principle of the familiar property of the curve of displacement. 3000 w. Int Marine Engng—May, 1906. No. 76422 C.

Steamers.

The London County Council Passenger Steamers. Archibald Hogg. A criticism of the steamers designed for this service, with general discussion. Ills. 3000 w. Trans N E Coast Inst of Engrs & Shipbldrs—March 16, 1906. No. 76695 D.

The Turbine-Driven Channel Steamer "Viper." Illustration, with description and report of trials. The vessel is to be used in the mail service between the Clyde and Belfast. 800 w. Engng—May 18, 1906. No. 77014 A.

Tail-Shafts.

Vickers' Appliances for Preserving and Lubricating Tail-Shafts. Illustrates and describes an arrangement for enabling oil to be used as a lubricant in the stern-tubes of steamers without its leaking away into the sea, and also preventing sand entering the stern-tube. 1500 w. Engng—May 4, 1906. No. 76669 A.

Yachts.

Steam Yachts: Some Comparisons. J. R. Barnett. Read before the Inst. of Naval Archts. Makes comparisons showing the most important changes made during the last twenty-five years. 2200 w. Engng—May 4, 1906. No. 76668 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Austin.

The Austin Petrol Cars. Begins an illustrated description of a British model, the leading characteristics, and details of construction. 1800 w. Auto Jour—May, 5, 1906. Serial. 1st part. No. 76654 A.

The Austin 25-30 H. P. Car. Describes interesting details of these cars, illustrating the petrol tank arrangement. 2000 w. Autocar—April 28, 1906. No. 76555 A.

Bicycle Gear.

The Pedersen Three-Speed Bicycle Gear. Illustrated description of an ingenious gear. 2000 w. Engng—May 11, 1906. No. 76764 A.

Brake Horsepower.

Brake Horsepower of Four-Cycle Motors. George W. Rice. Explains formula developed by the writer, and chart. 500 w. Automobile—May 24, 1906. No. 76796.

Carbureter.

The Carbureter and Its Functions. An explanation of the principles involved in modern carbureters, with remarks. Ills. 2000 w. Automobile—May 3, 1906. No. 76486.

Clement-Talbot.

The Clement-Talbot Petrol Cars. Principally an illustrated detailed description of the new 20 H. P. all-British vehicle. with general information in regard to the works and output of this company. 1200 w. Auto Jour—May 12, 1906. Serial. 1st part. No. 76753 A.

De la Buire.

The De la Buire Cars. Illustrates and describes details of these interesting French Cars. 2500 w. Autocar—May 19, 1906. No. 76985 A.

Depreciation.

Car Depreciation. J. T. Ward. Discusses detail of depreciation and thinks as long as it does not exceed 15 to 20 per cent per annum, it is not excessive.

1500 w. Autocar—April 21, 1906. No. 76434 A.

Education.

An Automobile School. An account of a school opened in New York for training in the principles involved in the construction and operation of automobiles of all types. Ills. 1000 w. Sci Am—May 26, 1906. No, 76786.

Electric.

The Electric Vehicle. Hayden Eames. Discusses its present status and its relation to the central station, the care needed and requirements. Ills. 3300 w. Elec Jour—May 1906. No. 76705.

Engines.

The Körting Paraffin Engine. Illustrates and describes a twelve-cylinder engine working in a special two-stroke cycle. 500 w. Autocar—May 5, 1906. No. 76656 A.

Gears.

The Humphrey-Scowen Gear Mechanism. Illustrations, with description. The chief features are the prevention of gear changing without declutching, and the facilitation of changing. 1200 w. Autocar—April 28, 1906. No. 76556 A.

Heavy Vehicles.

The Heavy Motor Vehicle Industrially Considered. John McGeorge. A comparative illustrated study of the advantages of electric propulsion as compared with steam and oil motors. 5000 w. Engineering Magazine—June, 1906. No. 76876 B.

Horse-Power.

Cubical Contents and Horse-Power. D. M. Weigel. A suggested method for calculating the actual power of engines by the cubical contents of their cylinders. 2000 w. Autocar—April 21, 1906. No. 76432 A.

Hotchkiss.

The Hotchkiss Cars. A brief illustrated description. 1300 w. Autocar—May 5, 1906. No. 76655 A.

Matheson.

Self-Starting is a Feature of This Car. An illustrated description of the starting device of cars built in Wilkes-Barre, Pa. 1700 w. Automobile—May 24, 1906. No. 76707.

Motor Cars.

Mechanical Features of Some of the Winning Cars in the Automobile Club of America's Two-Gallon Fuel Contest. Illustrated description of interesting features. 2000 w. Sci Am Sup—May 19, 1906. No. 76690.

Motor Races.

The Motor Races at Monaco. An illustrated account of the races with remarks on the development in motor craft. 5000 w. Autocar—April 21, 1906. No. 76433 A.

Omnibuses.

Motor Omnibuses for Public Passenger Service. R. G. L. Markham. An illustrated review of the history of motor vehicles for carrying passengers, their recent development and advantages. 3300 w. Cassier's Mag—May, 1906. No. 76483 B.

The "Electrobus" and Its Financial Prospects. Discusses the prospects of the electric omnibus in London, the running costs, re-charging expenses, cost of up-keep, mechanical features, etc. Ills. 2000 w. Auto Jour—April 28, 1906. No. 76558 A.

The 35-H. P. Napier Petrol 'Bus. Illustrated detailed description of the chassis, which is specially designed to take a double-deck 'bus body. 1000 w. Auto Jour—April 28, 1906. No. 76557 A.

The Transport of Passengers and Luggage by Heavy Motor Vehicles (Personen und Güterbeförderung mit Schweren Motorwagen). A. Heller. An illustrated discussion of the capabilities of the motor omnibus, showing vehicles used in Berlin, London and Brussels, with details of motors, tires, and gearing. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—May 5, 1906. No. 76806 D.

Works.

The Daimler Motor Car Works. Illustrated description of these fine works which have recently been extended. 2500 w. Engr, Lond—May 4, 1906. No. 76664 A.

COMBUSTION MOTORS.

Design.

Current Practice in Petrol Engine Design. G. W. Rice. Derives rational machine formulae for the different parts of a petrol engine with the constants of the formulæ derived from practice. 2500 w. Sib Jour of Engng—May, 1906. Serial. 1st part. No. 77027 C.

Engines.

British Marine Oil and Spirit Engines. Edward Butler. Presents the advantages and disadvantages of vapor motors, and experience previous to the introduction of the explosion principle, and since, giving illustrated descriptions of various designs of motors. 7500 w. Rudder—May, 1906. No. 76587 C.

Gas Engines.

A Heavy Duty Gas Engine Installation in the Carnegie Technical Schools' Plant, Pittsburgh, Pa. Illustrated detailed description of the four-cylinder double acting 500 H. P. engine. 2800 w. Ir Age—May 17, 1906. No. 76673.

Korting Gas Engine. Illustrates a 350-H. P. intermediate type, and a 250-H. P. engine embodying the latest modifications. 300 w. Engr, Lond—May 18, 1906. No. 77019 A.

Producer Gas.

Gas Producers for Power Purposes Oskar Nagel. Briefly refers to the Dawson, and Mond processes, and gives an illustrated description of a modern producer made by Ernest Koerting, and gives information relating to such plants. 1500 w. Eng News—May 17, 1906. No. 76679.

The Production of Power Gas from Lignite (Die Vergasung der Braun-Kohle zu Motorische Zwecken). H. Neumann. A discussion of various forms of gas producers, purifiers, and auxiliary apparatus for the generation of power gas from lignites and brown coals. Serial. Part I. Zeitschr d Ver Deutscher Ing—May 12, 1906. No. 76816 D.

The Use of Producer Gas for Power Generation. Godfrey M. S. Tait. Shows that the variable element in producer gas is due to the continually changing volume of the hydrogen constituent, and describes the Combustion Utilities Co.'s process for the regulation of flame and combustion temperatures, giving results obtained. 2200 w. Eng Rec—May 19, 1906. No. 76735.

Suction Gas.

Developments in the Construction of Suction Gas-Producers. William A. Tookey. Abstract of a paper before the Jr. Inst. of Engrs., with editorial. Showing the stage to which design has arrived as the result of experience. 7000 w. Jour of Gas Lgt—April 24, 1906. No. 76533 A.

Vaporizer.

Gardner's Vaporizer for Oil Engines. Illustrated detailed description. 900 w. Mech Engr—April 28, 1906. No. 76559 A.

See also Mechanical Engineering, Automobiles.

HEATING AND COOLING.

Bank Heating.

Heating and Ventilating the National Park Bank, New York. Illustrated description of a system of direct radiation, with auxiliary indirect apparatus for ventilating, used in a T-shaped building. 1000 w. Heat & Vent Mag—May, 1906. No. 76700.

Churches.

Church Sanitation. William Paul Gerhard. A discussion of church hygiene, and also the design, materials, and various matters relating to these buildings. Heating and ventilation are especially considered. 3300 w. Am Archt—May 26, 1906. No. 76961.

City Hall.

Low Pressure Heating and Ventilating Plant at the New City Hall at Frankfurt-on-the-Main (Die Niederdruckdampfheizungs und Lüftungsanlagen im Neuen Rathause zu Frankfurt a. M.). With plans and sections of the buildings showing the arrangement of the radiators and the ventilating ducts. 1800 w. 2 plates. Gesundheits-Ingenieur—March 24, 1906. No. 76839 D.

Custom House.

Heating and Ventilating System of the New Custom House in New York. A seven-story granite and steel building in which the indirect heating system is used, except in a portion to be devoted to Post-Office purposes, where auxiliary direct radiation is installed. Ills. 5000 w. Eng Rec—May 26, 1906. No. 76959.

Exhaust.

The Theory of Heating with Exhaust Steam (Zur Theorie der Abdampfheizung). Dr. B. Biegeleisen. A comparison of the relative efficiencies of exhaust steam-heating and the condensation of exhaust steam for power production. 5000 w. Gesundheits-Ingenieur—March 31, 1906. No. 76840 D.

Radiator.

The Kaeferle Low-Pressure Radiator (Kaeferles Patent Niederdruckdampf Heizkörper). Describing an arrangement of injector nozzle by which the movement of the incoming steam effects a positive circulation in the radiator. 1500 w. Gesundheits-Ingenieur—April 28, 1906. No. 76841 D.

School.

The Heating and Ventilation of the New Tacoma High School. Briefly describes the building showing the difficulties to be met in heating, and illustrates and describes the system of direct and indirect radiation, operated by exhaust steam with the Webster vacuum system of steam circulation and Johnson pneumatic heat regulating apparatus. 4000 w. Eng Rec—May 5, 1906. No. 76524.

Thermostat.

The Automatic Regulation of the Temperature of Rooms (Die Selbst-regelung der Raumtemperatur). Describing an electric thermostat for the control of steam and hot-water radiators. 2000 w. Gesundheits-Ingenieur—April 28, 1906. No. 76842 D.

Trap.

See Mechanical Engineering, Steam Engineering.

Ventilation.

A Scotchman's Notes on Ventilation. Alexander MacKenzie. From a paper read before the Edinburgh Sanitary Soc. Discusses methods in use, compares the extraction and the plenum systems, favoring the former. 4000 w. Heat & Vent Mag—May, 1906. No. 76701.

HYDRAULICS.

Centrifugal Pumps.

Sulzer High-Pressure Centrifugal Pumps in Practical Service (Sulzer Hochdruck-Kreiselpumpen in Praktischen Betriebe). Julius Divis. A review of the paper by Ziegler at the Liége Congress, showing efficiencies of more than 75 per cent against the heads of over 400 metres. Two articles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 14, 1906. No. 76827 each D.

Niagara.

The Diversion of Water from Niagara. Alton D. Adams. Gives a review of the plants along the water front of the park, aiming to show that only a small part of the water diverted in Queen Victoria Park could have found its way to the American Falls. 1600 w. Elec Wld—April 28, 1906. No. 76592.

Turbines.

A New Method of Turbine Control. Lamar Lyndon. Illustrates and describes a new method of turbine control, giving formulæ and facts on which the design is based. It consists primarily in changing rapidly the gate-opening of the turbine without changing the pressure or velocity of the water. 3500 w. Pro Am Inst of Elec Engrs—May, 1906. No. 76943 D.

Notes on the Characteristics of the Francis Turbine (Beiträge zur Charakterisk der Francis Turbine). Robert Löwy. Deriving constants for use in the classified formulas for turbine computations for wheels of the Francis type, according to the head and velocity. 2500 w. Elektrotech u Maschinenbau—April 15, 1906. No. 76845 D.

Pressure on the Pivot of the Jonval Turbine (Der Druck auf den Spurzapfen der Jonval Turbinen). Dr. Karl Kobes. A mathematical study of the water pressures in turbines of the Jonval type, showing the proportion of the vertical pressure to be supported by the step bearing of the shaft. 6000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 20, 1906. No. 76821 D.

Water Power.

The Commercial Utilization of the Hydraulic Power of the Upper Rhine from Neuhausen to Breisach (Die Wasser Kräfte des Oberrheins von Neuhausen bis Breisach und ihre Wirtschaftliche Ausnützung). H. E. Gruner. A review of the flow of the Rhine below the Falls and above Colmar, showing the points at which power developments are practicable. 2000 w. Schweiz Bauzeitung—May 12, 1906. No. 76844 B.

MACHINE WORKS AND FOUNDRIES.

Castings.

Some old Bronze Castings. Illustrates and describes interesting castings found at Pompeii and Herculaneum. 1200 w. Foundry—May, 1900. No. 76709.

Chains.

Chain Making: Its History and Development. Andre Jockaru. Illustrated description of the Lelong chain machine, the latest device for rapid production. 4800 w. Ir Trd Rev—May 3, 1906. No. 76487.

Chain-Making Machinery. Emile Lelong. Illustrates and describes the Lelong chain-making machine and its operation, with remarks on the advantages and on other processes. 2000 w. Ir & St Inst—May, 1906. No. 76918 N.

Core-Making.

Mechanical Core-Making Machines. Illustrates and describes a variety of these machines. 2500 w. Ir & Coal Trds Rev—May 11, 1906. No. 76926 A.

Cutting-Off.

An Analysis of the Cutting-Off Machine. Frederic R. Honey. An examination of the mechanism of the Pratt & Whitney cutting-off machine. 1500 w. Am Mach—Vol. 20. No. 19. No. 76609.

Drafting.

Economical Equipment and Management of the Drafting Room. T. D. Perry. Discussing especially systematic methods of storing and filing records, data, and drawings. 3000 w. Engineering Magazine—June, 1906. No. 76875 B.

Engraving.

A New Machine for Engraving Steel Plates. A. Frederick Collins. Illustrates and describes a machine invented by William S. Eaton, which is said to do the work better and cheaper than a skilled engraver. 1500 w. Sci Am—May 19, 1906. No. 76686.

Fire Arms.

The Manufacture of Colt's Automatic Army Pistol. An illustrated description of some of the interesting machine operations, and the machines used. 1700 w. Mach, N Y—May, 1906. No. 76464 C.

Forging.

Forging Presses. Illustrates a model of 3000-ton forging press, and describes the work done, and the improvements recently introduced. 3000 w. Engr, Lond —April 27, 1906. No. 76580 A.

Foundries.

A Modern Foundry Plant (Eine Moderne Giessereianlage). G. Rietkötter. A detailed description of an enlarged and rebuilt foundry plant, representing modern German practice, with plans and elevations of the buildings, and photographs of interior. Serial. Part I. 3500 w 2 plates. Stahl u Eisen—May 1, 1906. No. 76811 D.

Foundry Costs. R W. McDowell. Describes a cost system intended to meet the requirements of the general foundry. 5500 w. Foundry—May, 1906. No. 76708.

Foundry Department of the Ingersoll-Rand Co., Phillipsburg, N. J. Illustrated description of a plant for constructing a varied line of castings. 1700 w. Foundry—May, 1906. No. 76707.

Pipe Founding in Canada. Illustrated detailed description of the plant of the

Montreal Pipe Foundry Co., Ltd., at Three Rivers, Province of Quebec, and the mode of manufacture. 3000 w. Can Engr—May, 1906. No. 76625.

Furnaces.

Tube Welding Furnaces (Die Gas rohrschweissofen). Anton Bousse. With illustrations of reverberatory furnaces for the heating of tubes prior to lap-welding. Serial. Part I. 3000 w. Stahl u Eisen—May 15, 1906. No. 76814 D.

Grinding.

The Grinding of Accurate Duplicate Tool Steel Parts. Joseph V. Woodworth. Illustrates and describes fixtures used to assist in the cheap production of interchangeable parts of tool steel. 1000 w. Ir Trd Rev—May 3, 1906. No. 76488.

Interchangeable Parts.

Manufacturing Interchangeable Machine Parts. John H. Barr. An introductory discussion of the development of labor-saving, especially in the United States, with remarks on the advantages of interchangeable parts, and a general consideration of the methods of duplicating. 7000 w. Sib Jour of Engng—May, 1906. No. 77026 C.

Iron Work.

Ornamental Iron Work. A topical discussion opened by W. N. Kratzer. 4000 w. Pro Engrs Soc of W Penn—May, 1906. No. 76907 D.

Lathes.

Electrically-Driven "All-Gear" Lathe. Illustration, with description of a lathe designed to do away entirely with the necessity for counterdrafting. There are sixteen direct spindle speeds. 800 w. Engng—May 11, 1906. No. 76763 A.

High-Speed Lathes. Illustrates and describes some special high-speed lathes for heavy bar turning and general work. 1000 w. Engr, Lond—May 11, 1906. No. 76768 A.

Large Gap Lathe. Illustrated description of a large sliding and surfacing lathe for turbine rotors and other work. 500 w. Engng—April 20, 1906. No. 76455 A.

Machine Design.

The Relation of Mechanics to Machine Construction (Die Mechanik in ihrer Bedeutung für den Maschinenbau). H. Lorenz. An address showing the great practical utility of the modern science of mechanics and kinematics in connection with the construction machines. 5000 w. Zeitschr d Ver Deutscher Ing—April 28, 1906. No. 76802 D.

Milling Machine.

Heavy Motor-Driven Milling Machine. An exceptionally powerful motor-driven duplex milling machine is illustrated and described. Built in Philadelphia. 400 w. Engng—April 27, 1906. No. 76575 A.

Press Feed.

An Automatic Press Feed. George Dean. Illustrated detailed description of an automatic strip feed for press. 1200 w. Am Mach—Vol. 29. No. 18. No. 76471.

Rolls.

Roll Grinding. C. H. Norton. States facts discovered during careful investigation of grinding rolls, with discussion of the reasons for the popular belief that rolls are practically perfect. 3000 w. Am Mach—Vol. 29. No. 18. No. 76469.

The Design of Bending Rolls. A. L. de Leeuw. Considers rolls of the pyramid type discussing their design, and illustrating the work by a practical example. 3800 w. Am Mach—Vol. 29. No. 20. No, 76685.

The Design of Billet and Bar Passes. B. H. Reddy. Gives a description of a method by means of which a series of such passes may be quickly proportioned. 1400 w. Mach, N Y—May, 1906. No. 76462 C.

Shops.

The Concrete Erecting Shop of the Ingersoll Milling Machine Company. Illustrated description of an example of reinforced-concrete construction, giving the specifications for reinforcement and other information. 1200 w. Mach, N Y—May 1906. No. 76461 C.

The Boiler Shop of the Titusville Iron Works. Joseph Y. Seyboldt. Illustrations with brief description. 500 w. Boiler Maker—May, 1906. No. 76598.

Stereotypes.

A New Device for the Making of Curved Stereotype Printing Plates for Newspapers. Describes the autoplate machine, and the recent Junior autoplate, for the use of offices where fewer plates are required. Ills. 1800 w. Sci Am Sup—May 26, 1906. No. 76790.

Tools.

The Thor Pneumatic Tools. Illustrates and describes improvements introduced in pneumatic drills and hammers. 1700 w. Ir Age—May 24, 1906. No. 76769..

Wheels.

Processes of Car Wheel Manufacture. Brief illustrated descriptions of the processes as carried out at various foundries. 5500 w. Ir & Coal Trds Rev—May 11, 1906. No. 76925 A.

MATERIALS OF CONSTRUCTION.

Alloys.

The Equilibrium Curves of the System Iron and Carbon. Prof H. v. Jüptner. A revision of results obtained in experimental investigations, discussing the equilibrium curves. 800 w. Ir & St Mag—May, 1906. No 76798 D.

Cast Iron.

Influence of Silicon Phosphorus, Manganese, and Aluminium on Chill in Cast Iron. E. Adamson. Describes experiments made to determine the influence of these metalloids on chill, and to obtain comparative data on mechanical tests and other conditions. 5400 w. Ills. Ir & St Inst—May, 1906. No. 76919 N.

The Influence of the Condition of the Carbon upon the Strength of Cast Iron as Cast and Heat Treated. W. H. Hatfield. Abstract report of research work. 2000 w. Ir & Coal Trds Rev—May 11, 1906. No. 76922 A

Volume and Temperature Changes During the Cooling of Cast Iron. Thomas Turner. Remarks on attempts to measure shrinkage of cast iron, with description of apparatus adopted by the author, and method of determining temperature. Gives also particulars of the contraction and temperature changes of a few examples. 4000 w. Ir & St Inst—May, 1906. No. 76911 N.

Chemistry.

The Chemist in the Machine Shop. H. S. Brown. Shows the importance of having analyses of stock made in the construction of all machinery, and that it will add to the life of the finished machine and will reduce the cost. Ills. 2500 w. Ir Age—May 31, 1906. No. 77031.

Crucible Steel.

An Etching Method for Determining Whether Steel Has Been Made by the Crucible Process. James A. Aupperle. Describes the method used by the writer. 400 w. Ir & St Mag—May, 1906. No. 76799 D.

Heat Insulation.

Notes on Heat Insulation, Particularly with Regard to Materials Used in Furnace Construction. R. S. Hutton and J. R. Beard. Read before the Faraday Society. A report of experiments for the measurement of thermal conductivities of granular materials up to 100 degrees C. giving their relative value, and describing apparatus used. Ills. 1700 w. Sci Am Sup—May 5, 1906. No. 76503.

Pig Iron.

Grading Pig Iron. Reginald Meeks. Showing how much more reliable are irons mixed from grades by chemical analysis, than by the old method of grading by fracture. 1500 w. Eng & Min Jour—April 28, 1906. No. 76400.

Metallography.

Notes on Technical Details of Metallography (Einiges aus der Metallographischen Technik). P. F. Dujardin. Discussing details relating to the polishing of the metal surfaces and the arrangement of the microscope and camera for lighting and photographing the enlarged image. Serial. Part I. 3000 w. Stahl u Eisen—May 1, 1906. No. 76810 D.

Practical Application of Metallography in the Iron Industry (Ueber die Nutzanwendung der Metallographie in der Eisenindustrie). E. Heyn. A general review of the progress which has been made in the study of the physical constitution of the iron alloys, showing how the microscopic study of metals may be practically applied. 7500 w. Serial. Part I. Stahl u Eisen—May 15, 1906. No. 76812 D.

Steels.

Quaternary Steels. Leon Guillet. Abstract of research work on 12 varieties of these steels with conclusions. 6000 w. Ir & Coal Trds Rev—May 11, 1906. No. 76920 A.

Special Auto Steels and Their Properties. Rene M. Petard. Discusses special mixtures of steel, with reference to other materials. 2300 w. Automobile—May 10, 1906. Serial. 1st part. No. 76596.

Test-Pieces.

The Relation Between Type of Fracture and Micro-Structure of Steel Test-Pieces. C. O. Bannister. Report of researches, giving photographs of fractures of a number of types, with descriptions and examinations, with a summary of conclusions. 3500 w. Ir & St Inst—May, 1906. No. 76917 N.

Tool Steel.

High-Speed Steel in the Factory O M. Becker. Mr. Becker's sixth paper discusses the action of the tool at work, showing the conditions of maximum effect, and considering the proper care in the use of the tools. 3000 w. Engineering Magazine—June, 1906. No. 76877 B

Wire.

The Heat Treatment of Wire, Particularly Wire for Ropes. J. Dixon Brunton. Abstract of research work made with a view to ascertaining the correct heat treatment. 3800 w. Ir & Coal Trds Rev—May 11, 1906. No. 76921 A.

Wood Pulp.

Brimstone versus Pyrite for Wood-Pulp Manufacture. Ernst A. Sjostedt A comparison of the value of brimstone and pyrite for sulphite pulp making 1500 w Eng & Min Jour—April 28, 1906. No. 76399.

MEASUREMENT.

Beams.

Sections of Cast Iron Beams. C H Benjamin. Presents results of interesting experiments made by students of the Case. School to determine the relative strength and stiffness of cast-iron beams having cross-sections of the same area but of different shapes. 2000 w. Mach. N Y—May, 1906. No. 76460 C.

Calorimeter.

Alcohol Calorimeter for Coal Testing. W. M. Wallace. Describes methods of using calorimeters, especially the good results obtained with the alcohol calorimeter. 1200 w. Engng—April 20, 1906. No. 76456 A.

Indicators.

The Calibration of Indicator Springs (Bestimmung ueber die Feststellung der Mass stäbe für Indikatorfedern). C. Bach. A report of the joint committee of the *Reichsanstalt* and the *Verein Deutscher Ingenieure* upon standard methods of standardizing the springs of steam-engine indicators; with practical examples and a brief bibliography. 3000 w. Zeitschr d Ver Deutscher Ing—May 5, 1906. No. 76808 D.

Metric System.

Tennessee Congressman Denounces Metric System. John Wesley Gaines. Objects to the French methods being made compulsory, showing the ample freedom existing under the present law. 2800 w. Am Mfr—May 10, 1906. No. 76595.

Pyrometers.

Improved Industrial Thermo-Electric Pyrometers (Nouveaux Pyrometres Thermo-Electriques Industriels). M. Pillier. Describing a pyrometer of the Le Chatelier type, in which the thermo-electric couple is made of an alloy of copper, nickel, and manganese. 4000 w. Bull Soc Int des Electriciens—April, 1906. No. 76864 G.

Speed Recorder.

A Speed and Mileage Recorder for Automobiles and Railroads. A new type of recorder recently introduced in Great Britain is illustrated and described. It is said to be infallible in its operation. 1200 w. Sci Am Sup—May 12, 1906. No. 76633.

A Unique German Speed Gauge. F. C. Perkins. Illustrated description of a speed gauge for determining the speed of machines. It is an ingenious application of the property of resonance and was designed by Hermann Frahm. 700 w. Min Rept—May 3, 1906. No. 76538.

Springs.

The Calculations for Tension Springs for Electrical and Mechanical Apparatus (Berechnuug von Zugfedern für Elektrische und Mechanische Apparate). Robert Edler. Applying the usual formulas to the light wire helical springs used in electrical work, with computed tables for various materials. Serial. Part I. 3000 w. Elektrotech u Maschinenbau—April 29, 1906. No. 76848 D.

Standards.

The National Bureau of Standards at Washington. Illustrations of the buildings and equipment used, with description of the work being done. 4000 w. Am Mach—Vol. 29. No. 20. Serial. 1st part. No. 76684.

POWER AND TRANSMISSION.

Compressed Air.

Modern Methods of Rock Excavation. Describes the work accomplished by well drilling machines operated by compressed air on heavy contract work. Ills. 1700 w. Compressed Air—June, 1906. No. 77153.

The Comparative Merits of Air and Electric Drills. Granville E. Palmer. Considers the electric apparatus unsuited to this work. 800 w. Compressed Air—June, 1906. No. 77152.

Conveyors.

Coal-Handling Plant of the Long Island City Power House of the Pennsylvania Railroad. An illustrated article dealing in detail with the coal and ash-handling equipment of this station. 4000 w. Power—June, 1906. No. 76751 C.

Elevating and Conveying Machinery. S. F. Joor. Illustrated descriptive review of various types of this class of machinery both for carrying articles in bulk and for carrying packages of various kinds. Also discussion. 1200 w. Jour W Soc of Engrs—April, 1906. No. 76930 D.

Mechanical Handling of Coal, Ashes, and Clinker, at the Electricity Station, Ivry, of the Paris-Orleans Railway. The arrangement for automatic coaling and mechanical stoking is illustrated and described. 1800 w. Ir & Coal Trds Rev—May 18, 1906. No. 77025 A.

The Automatic Conveyor in Lumbering. Day Allen Willey. Illustrates and describes conveying machinery used in connection with lumbering, saw-mills, pulp factories, and other wood-working establishments. 900 w. Sci Am—May 5, 1906. No. 76497.

Cranes.

100-Ton Electric Derrick Crane at Scotts' Dock, Greenock. Illustrated description. 1000 w. Engng—April 27, 1906. No. 76572 A.

Electric Driving.

Electric Power for Clay Plants from an Engineers' Point of View. Victor C. Vance. Read before the Nat. Brick Mfr's. Assn. A consideration of the comparative merits of belt and electric transmission of power. 2500 w. Brick—May, 1906. Serial. 1st part. No. 76586.

Motor Drive in the Firth-Sterling Steel Company's Plant. Illustrated description of a typical installation of the Westinghouse direct-current motors, known as the S A type, in a new projectile shop at Demmler, Pa. 1500 w. Ir Age—May 31, 1906. No. 77029.

Elevators.

Elevator Safeties at the Hotel Belmont. Describes the safety provisions for elevators operated at unusual heights and speeds. They are designed to carry 2,500 to 3,000 lbs. at a maximum speed of 500 ft. per minute. Ills. 2700 w. Eng Rec—May 19, 1906. No. 76738.

Gears.

A Method of Procedure in the Design of Helical Gears. R. E. Flanders. Describes a method which the writer thinks reduces the most serious of this class of problems to its simplest elements. 3500 w. Mach, N Y—May, 1906. No. 76463 C.

Hoists.

Lifts and Hoists. H. C. Crews. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Reports investigations and tests of an equal number of hydraulic and electric lifts as to energy, maintenance, total costs, etc. The commercial side of the subject mainly. 4000 w. Elect'n, Lond—April 20, 1906. No. 76441 A.

Mechanical Plant.

The Mechanical Plant of the Ford Memorial Building, Boston. Brief description of this 8-story, steel and brick building and its uses, with detailed description of the plant for ventilating, heating, lighting, elevator service and furnishing power for other machinery. Ills. 5500 w. Eng Rec—April 28, 1906. No. 76416.

STEAM ENGINEERING.

Boilers.

Boiler Setting. C. L. Hubbard. An illustrated article considering especially horizontal tubluar boilers. 900 w. Engr, U S A—May 15, 1906. Serial. 1st part. No. 76744 C.

Double-Ended Water-Tube Boiler. A report of the experimental tests made with the double-ended Yarrow boiler. 1200 w. Engng—April 27, 1906. No. 76574 A.

Horse Power of Boilers. Roger Atkinson. An explanation of methods of calculating. 800 w. Ry & Soc Engng—June, 1906. No. 77102 C.

Steam Boilers at the Liége Exposition (Ueber das Dampfkesselwesen auf der Weltausstellung zu Lüttich). With illustrations of the various boilers exhibited, including also superheatetrs and boiler attachments. 3500 w. Glückauf—April 21, 1906. No. 76822 D.

Cost.

Elements Influencing the Cost of Steam Power (Was Beeinflusst die Kosten der Dampfkraft?). H. Fischer. Deriving diagrams for use in showing the relative influence of boiler proportions, superheating, condensing, and engine performance upon the cost of steam power. 1500 w. Zeitschr d Ver Deutscher Ing—April 28, 1906. No. 76804 D.

Engines.

The Multiplication of Impulses. A. E. Ash. Reviews the development of the marine engine, showing the way the marine engineer has successfully multiplied the number of impulses and reduced the units of force. Ills. 1000 w. Autocar—April 21, 1906. No. 76431 A.

Exhaust Steam.

Utilizing Exhaust Steam in Low-Pressure Turbine Plant at Collieries. Hundt, in *Glückauf*. Illustrates and describes the plant at the Bruay collieries. The steam is derived from Rateau accumulators and discharged into high-vacuum condensers. 1600 w. Col Guard—April 27, 1906. No. 76569 A.

Governors.

Ruston and Recke's Shaft Governor. Illustrated description of a design of centrifugal shaft governor, recently patented. 1000 w. Mech Engr—May 5, 1906. No. 76659 A.

See Electrical Engineering, Generating Stations.

Losses.

Central Station Boiler-Room Losses. T. R. J. Orr. Calls attention to some sources of waste which can easily be kept in hand, which arise to alarming proportions if neglected. 3500 w. Elec Engr, Lond—May 4, 1906. No. 76660 A.

Lubrication.

Oil Required for Lubrication. Charles N. Bain. Calls attention to points to be considered in determining the amount of oil used. Ills. 1000 w. Elec Wld—May 5, 1906. No. 76552.

Nomenclature.

The Advantages of Employing Electrical Engineering Nomenclature in Steam Engineering Calculations. H. M. Hobart. Presents some of the advantages, with tables. 1700 w. Elec Rev, Lond—April 27, 1906. Serial. 1st part. No. 76562 A.

Powdered Coal.

Powdered Coal Firing for Steam Boilers. Geo. C. McFarlane. Illustrates and describes the burning of powdered coal with an air blast, and gives an estimate of comparative costs with hand-firing. 1000 w. Eng & Min Jour—May 12, 1906. No. 76607.

Smoke.

The Economy of Smoke Abatement. A. S. Atkinson. Discusses methods of securing perfect combustion of fuel. 2000 w. Boiler Maker—May, 1906. No. 76599.

Steam Heating.

See Mechanical Engineering, Heating and Cooling.

Superheating.

See Railway Engineering, Motive Power and Equipment.

Testing.

Steam Consumption Test on a Twin Tandem Compound Condensing Winder at No. 1 Shaft, Village Deep, Ltd., on 15th February, 1906. Messrs. E. J. Laschinger, A. M. Robeson and H. C. Behr. Describes efficiency tests for winders of recent construction and gives results. Ills. 9000 w. Jour S. African Assn of Engrs—March, 1906. No. 76428 F.

Trap.

The Steam Trap. R. T. Strohm. Illustrated descriptions of types of this device, which is designed to remove the water of condensation from any vessel under pressure without allowing the escape of steam. 3000 w. Power—June, 1906. No. 76752 C.

Turbines.

Brake Tests of a 500-Kw. Westinghouse-Parsons Turbine. An account of some runs made at Atlanta, at the works of the Westinghouse Machine Co., with curve sheet. 1200 w. Eng Rec—May 19, 1906. No. 76737.

Condensing Machinery for Steam Turbines. Illustrated description of two types of sub-base condensers designed specially for working in conjkunction with steam turbines of the Curtis type. 700 w. Engng—April 20, 1906. No. 76453 A.

Some Practical Experiences with Steam Turbines. C. E. Stanton. Read before the Iowa Elec. Assn. Describes things learned in the practical operation of steam turbines. 2500 w. St Ry Jour —April 28, 1906. No. 76411 C.

Steam Turbines for Variable Loads. Illustrated description of a steam turbine patented by W. J. A. Loudon, designed to run efficiently at light loads. 1200 w. Mech Engr—April 21, 1906. No. 76442 A.

See also Electrical Engineering, Generating Stations.

Valves.

Setting the Valves of the Fleming Piston Valve Engines. Thomas Hall. Illustrated description of method. 2000 w. Power—June, 1906. No. 76747 C.

MISCELLANY.

Aeronautics.

The Flying and Soaring of Birds Explained by Well-Known Mechanical Principles. H. LaV. Twining. Presents results of experiments and observations, explaining the fundamental principles. Diagrams. 5000 w. Sci Am Sup—May 5, 1906. No. 76504.

Air Resistance.

Experiments to Determine the Relation Between Air Resistance and the Form of a Moving Body (Versuche zur Ermittlung der Abhängigkeit des Luftwiderstandes von der Gestalt der Körper). Albert Frank. Data and results of experiments upon prismatic and conical bodies, showing the reduced resistance for the latter forms. 4000 w. Zeitschr d Ver Deutscher Ing—April 21, 1906. No. 76800 D.

Engineers' Club.

Electrical and Mechanical Equipment of the New Engineers' Club Building, New York. Describes the general plan of this fine building in New York City, and the details of its electrical and mechanical equipment. Ills. 3000 w. Elec Wld—May 19, 1906. No. 76741.

Invention.

Discovery and Invention. Edward Goodrich Acheson. A lecture before the students of Sibley College. Briefly notes examples of discovery without invention, invention without discovery, and discovery with invention, and gives an interesting review of the writer's personal work. 4500 w. Sib Jour of Engng—May, 1906. No. 77028 C.

Oxygen.

The Production of Oxygen and Nitrogen from Liquid Air (Ueber die Herstellung von Sauerstoff und Stickstoff aus Verflüssigter Luft). F. Linde. A review of the progress which has been made in the fractional distillation and rectification of liquid air; discussing also the practical uses of the oxygen and nitrogen thus obtained. 2500 w. Zeitschr d Ver Deutscher Ing—April 28, 1906. No. 76803 D.

Photography.

Technical Photography. Frederick Henius. Discusses the photographing of machinery and interiors; the outfit needed, and factors of importance. Ills. 4000 w. Pro Engrs Soc of W. Penn—May 1, 1906. No. 76906 D.

Solar Heat.

The Utilization of Solar Heat for Industrial Purposes by Means of a New Plane Mirror Reflector. Carl Güntner. Illustrates and describes a new method of reflector construction, by the use of plane mirrors, discussing the application to practical uses. 6800 w. Sci Am Sup May 26, 1906. No. 76789.

Theater Plant.

Power Plant of the Majestic Theater Building. Illustrated detailed description of a plant that supplies light, heat and power to a 20-story office building and a 9-story theater in Chicago. 4000 w. Engr, U S A—May 15, 1906. No. 76743 C.

MINING AND METALLURGY.

COAL AND COKE.

Alaska.

The Matanuska Coal Field, Alaska. William Griffith. Maps and description of an extensive area underlaid by coal of good quality. 4800 w. Mines & Min—May, 1906. No. 76508 C.

Briquettes.

Briquetting of Brown Coal. K. A. Muellenhoff. Gives a description of the briquetting plant of the Lauchhammer Company, a well known iron and steel works in Saxony. The process is quite different from the briquetting of anthracite coal dust and slack coal, as no binder is necessary. Ills. Discussion. 5600 w. Pro Engrs Soc of W Penn—May, 1906. No. 76908 D.

Classification.

Classification of Coals. Marius R. Campbell. Proposes a scheme for accurately defining the classes of coal, which will apply to liquids as well as bituminous coal and anthracite. 2700 w. Min Rept—April 26, 1906. No. 76405..

Coal Cutting.

The Introduction of Coal-Cutting Machinery. J. S. Ward. Read before the Nat. Assn. of Col. Engrs. Considers the working of thin seams, the methods of getting coal, the essentials of a good coal-cutting machine, and related matters. Discussion. 5000 w. Ir & Coal Trds Rev—April 27, 1906. No. 76583 A.

Coal Measures.

The Occurrence of True Coal Measures at Port Seton, East Lothian. E. B. Bailey, and D. Tait. Abstracted from Trans. of the Edinburgh Geol. Soc. Describes the geology of this region. Map. 2000 w. Col Guard—April 20, 1906. No. 76448 A.

Coal Tests.

The Government Coal Tests. Samuel Sanford. A review of the report of the Coal Testing Operations of U. S. Geological Survey. 3300 w. Eng & Min Jour—April 28, 1906. No. 76401.

Disaster.

The Courrières Disaster. James Ashworth. Information of the character and extent of the mines, the probable cause of the explosion, and illustrated description of rescue apparatus. Also editorial. 3000 w. Mines & Min—May, 1906. No. 76513 C.

Electric Blasting.

Electric Blasting Apparatus, with Special Reference to its Use in Coal Mines. W. Maurice. The present number considers fuses and exploders. Ills. 2200 w. Elect'n, Lond—May 18, 1906. Serial. 1st part. No. 76989 A.

Electric Plants.

The Installation and Working of Electric Plants at Collieries. S. T. Boam. Read before N. Assn. of Col. Mgrs. Considers the generation of steam and the engine, the dynamo or generator, system of distribution motors, etc. 3500 w. Ir & Coal Trds Rev—April 20, 1906. No. 76458 A.

Explosives.

Bobbinite in Coal Mines. Gives evidence in regard to this explosive as used in coal mines, presented before the Home Office Committee. 8000 w. Ir & Coal Trds Rev—May 4, 1906. No. 76671 A.

Gases.

Some Practical Notes on the Detection and Estimation of Inflammable Gases in Mines by Means of Flame Caps. Prof. Charles Latham. Abstract of a paper before the Min. Inst. of Scotland. Points out improvements made in connection with safety lamps intended for flame cap testing. 2000 w. Col Guard—April 20, 1906. No. 76446 A.

Haulage.

Endless Rope Surface Haulage at Shilbottle Colliery. Describes the system of haulage, giving map showing route, and illustrations. 2800 w. Ir & Coal Trds Rev—May 4, 1906. No. 76672 A.

The Alliance Rack Rail Locomotive Haulage System. Shows that for grades in coal mines some form of mechanical haulage more positive than a traction locomotive is required, and presents the advantages of the system named, giving an illustrated description. 4500 w. Ir & Coal Trds Rev—May 18, 1906. No. 77023 A.

India.

Indian Coalfields. Map and information furnished by R. R. Simpson of the Geological Survey of India. Reports ten new fields and the re-examination of two previously known. 2000 w. Ir & Coal Trds Rev—April 27, 1906. No. 76582 A.

Indian Territory.

The Coal Fields of the McAlester Quadrangle, Indian Territory. H. A. Everest. Gives a general outline of the development and history of the field, and a description of the coals, their location, quality, and the methods of mining. 3000 w. Min Rept—May 17, 1906. No. 76718.

Mine Stables.

Underground Stables. Illustrates types of stables built of wood, iron, or concrete, and discusses the proper arrangement. 2000 w. Mines & Min—May, 1906. No. 76511 C.

COPPER.

Arizona.

In the Globe, Arizona, District. An illustrated report of properties in this copper district. 1800 w. Min Rept—April 26, 1906. No. 76406.

Cornish Mines.

A Mine Below the Sea, with a Sketch of the Cornish Lodes. Arthur Lakes. An illustrated description of the Botallack mine which yields tin and copper with information concerning the Cornish mines. 900 w. Min Wld—May 5, 1906. No. 76541.

Lake Superior.

History of the Lake Copper District. An interesting account of the early work of Dr. Douglass Houghton, and the development of what has proved one of the most valuable mining fields in the world. 2500 w. Min Wld—May 12, 1906. No. 76641.

Matte.

The Determination of Matte. John P. Walker. Gives the formula used in calculating the grade of matte to be expected from a calcine of given percentage of copper and sulphur, and explains its application. 1000 w. Eng & Min Jour—May 5, 1906. No. 76546.

New Mexico.

The Burro Mountain District. Illustration, with description of this district. The chief metal is copper, but a pay deposit of lead-silver ore occurs, and also a high grade lead ore. 2400 w. Min Rept—May 24, 1906. No. 76974.

Nickel Ores.

Genetic Relations of Some Nickel-Copper Ores. Charles W. Dickson. Read before the Can. Min. Inst. Briefly reviews the geological relations of nickel ores in general, and discusses the deposits of St. Stephen, N. B., and Sohland, Germany. 7800 w. Can Min Rev—May, 1906. No. 76973 B.

Ore Treatment.

Note on the Ammonia-Copper-Cyanide Process. E. Le Gay Brereton. A report of experimental investigations and results, which show that under certain conditions cuprous potassium cyanide in an ammoniacal solution is broken up with the liberating of an alkaline cyanide. 1500 w. Inst of Min & Met—March 15, 1906. No. 76995 N.

Note on the Ammonia-Copper-Cyanide Process. E. Le Gay Brereton. H. L. Sulman's discussion of this paper. 1700 w. Inst of Min & Met—March 15, 1906. No. 76997 N.

Production.

Arizona and Sonora. Dwight E. Woodbridge. The present article discusses the production of copper, and gives information concerning several of the districts. Ills. 1200 w. Eng & Min Jour—May 12, 1906. Serial. 1st part. No. 76605

The Direct Production of Copper. An illustrated detailed description of the Cowper-Coles centrifugal process for electrically depositing copper. 1700 w. Engng—May 18, 1906. No. 77013 A.

Quebec.

Copper Deposits of the Eastern Township of Quebec. John Alexander Dresser. Map of the district, with account of the early work, a classification of the deposits, and a few of the characteristics of the ore bodies included in the first class. 2800 w. Ec Geol—March, 1906. No. 76946 D.

Recovery.

The Recovery of Copper from Mine Drainage. Philip Argall. Briefly reviews the history of the precipitation of copper from mine drainage, which has been established about 200 years in Europe, and recently introduced in the western mines of the United States. 2500 w. Min & Sci Pr—May 19, 1906. No. 76981.

Rhodesia.

Some Copper Deposits in Rhodesia. C. Brackenburg. Describes deposits in South Eastern Rhodesia, examined by the writer. 4000 w. Inst of Min & Met—May 17, 1906. No. 77005 N.

Smelting.

A New Method of Smelting Butte Ores. William A. Heywood. Describes the application of the Baggally process to the smelting of copper ores. 3000 w. Min & Sci Pr—April 28, 1906. No. 76639.

The Colorimetric Estimation of Copper in Slags. H. M. Kimball. Gives a simple method of running the daily slag samples for copper. 700 w. Eng & Min Jour—May 19, 1906. No. 76728.

Sudbury.

Notes on the Origin of the Sudbury Ores. David H. Browne. A study of the ores and of the theories explanatory of their origin, with the writer's conclusions. 2500 w. Ec Geol—March, 1906. No. 76948 D.

On the Origin and Relations of the Nickel and Copper Deposits of Sudbury, Ontario, Canada. Alfred Ernest Barlow. Gives a historical résumé of the literature relating to this mining district, describing the ore deposits. 4000 w. Ec Geol—March, 1906. No. 76947 D.

Tailings.

The Cyanide Treatment of Cupriferous Tailings by the Sulphuric Acid Process. W. S. Brown. Describes the treatment of tailings that come principally from Cobar, N. S. W. Reviews the operations. 2000 w. Inst of Min & Met—March 15, 1906. No. 76994 N.

Utah.

Modern Mining at Alta, Utah. Leroy A. Palmer. An account of the revival of an old camp, producing copper, lead, gold and silver, as well as other ores of value. Ills. 4500 w. Mines & Min—May, 1906. No. 76509 C.

GOLD AND SILVER.

Alaska.

Gold-Mining in Alaska. Editorial, describing the deposits and giving an account of the difficulties in the different districts. 3000 w. Engng—April 27, 1906. No. 76573 A.

Vein Mining in Alaska. Chester W. Purington. Divides Alaska into three provinces, and discusses the prospects for vein mining in each. 1200 w. Min & Sci Pr—May 12, 1906. No. 76721.

Australia.

Progress of the Gold-Mining Industry of Western Australia. W. Burrell. Brief report of progress during the past year. Ills. 1500 w. Min Mag—May, 1906. No. 76903 C.

Black Hills.

Gold and Tin in the Northwestern Black Hills. Benjamin Sadtler. Report of the gold and tin bearing district in Crook County, Wyoming, and Lawrence County, South Dakota. The gold veins carry no tin, nor the tin veins any gold, but the placer regions carry both. The geology and development are described. Ills. 3500 w. Min Wld—April 28, 1906. No. 76407.

Chile.

The Mining District of Chanarcillo, Chile. Edward Halse. Deals with the distribution and concentration of the silver ores. 800 w. Min Jour—May 5, 1906. Serial. 1st part. No. 76657 A.

Cobalt.

The Cobalt-Mining District. Aldrea H. Brown. Information concerning this mining district of Ontario, Canada. Native silver, associated with argentite and various compounds of sulphur, arsenic and antimony, and smaltite, a diarsenide of cobalt, are the most valuable minerals. 1800 w. Min Wld—May 12, 1906: No. 76643.

The Occurrence and Development of the Cobalt Ore Deposits. . A. Macdonald. An illustrated account of the geological conditions in the cobalt district in northern Ontario, and the deposits of ores of silver, cobalt, nickel and arsenic. 3500 w. Engineering Magazine—June, 1906. No. 76878 B.

Concentration.

The Tempest-Apex Mill at Ouray, Colorado. Frank McLaughlin. Illustrated description of this concentrating mill, which treats a lead sulphide ore containing gold, silver, copper, lead and zinc. 1000 w. Min Rept—April 26, 1906. No. 76104.

Crushing.

Huntington Mill Notes. Cyril E. Parsons. Information in regard to Huntington Mills in Southern Rhodesia, with a detailed critical description of a single case. Ills. 6800 w. Inst of Min & Met—May 17, 1906. No. 77006 N.

Discussion.

A Record of an Investigation of Earth Temperatures on the Witwatersrand Gold Fields, and their Relation to Deep Level Mining in the Locality. Hugh F. Marriott. A discussion of this paper, introduced by the author. 5200 w. Inst of Min & Met—March 15, 1906. No. 76996 N.

Dredging.

Economy in Mining with Modern Gold-Dredges. George E. Walsh. Describes the modern gold dredging plant and its working, giving information concerning the cost for the plant, the working costs, etc. Ills. 2000 w. Min Wld—May 19, 1906. No. 76720.

The Bucket-Dredging Industry. E. Seaborn Marks and Gerald N. Marks. Discusses bucket-dredges and their construction, alluvial deposits suited to bucket-dredging, and the requisite conditions for successful operations; dredging operations and costs. Ills. 11000 w. Inst of Min & Met—April 19, 1906. No. 77002 N.

The Bucket-Dredging Industry. E. Seaborn Marks and Gerald N. Marks. Discussion of this paper. 6000 w. Inst of Min & Met—April 19, 1906. No. 77003 N.

Ecuador.

Gold-Dredging in Ecuador. Leonard L. Wetmore. Information concerning the placer fields and something of their history, showing the difference between modern methods of working placers and the crude methods adopted by the Spaniards. Ills. 3000 w. Min Mag—May, 1906. No. 76904 C.

Egypt.

Gold Mining in Upper Egypt. Ernest H. S. Simpson. From the Bul. of the Inst. of Min. & Met. Remarks on the results at Atallah, Eridea, and Semna, which give fair prospects of ranking high as producers. 2000 w. Min Jour—April 21, 1906. No. 76445 A.

Mexico.

Mining and Metallurgy in El Oro, Mexico. H. E. West. An account of the largest producer of gold in Mexico, and the third largest producer on the continent. Describes the district, deposits, ore treatment, sand treatment, power, etc. Ills. 7000 w. Min Mag—May, 1906. No. 76901 C.

The Peregrina Mill, Guanajuato. F. J. Hobson. Gives plan, cross-section, and description of the plant. The entire machinery is to be run with electric motors, the power being brought 103 miles. 800 w. Eng & Min Jour—May 19, 1906. No. 76730.

Montana.

The Cable Mountain Gold Mining District of Montana. W. D. Bohm. An illustrated historical account of this district, describing the ores, development, etc. 3000 w. Min Mag—May, 1906. No. 76902 C.

New South Wales.

The Mitchell's Creek Gold Mines, New South Wales. Wilfrid F. Macdonald. Gives the history, geology, and development of these mines, mining methods, treatment and costs. Ills. 4000 w. Inst of Min & Met—April 19, 1906. No. 77001 N.

Ore Treatment.

The Treatment of Temiskaming Low-Grade Ores. S. F. Kirkpatrick. Reports three methods of treatment investigated for these silver ores and gives a summary of the results obtained. 1400 w. Can Min Rev—May, 1906. No. 76971 B.

Parting.

A New Form of Platinum Parting Apparatus. A. Jarman. Illustrated description of a new form of tray, designed by Prof. Liversidge for use in the Sydnew Mint, with comparison with other forms. 1400 w. Inst of Min & Met—May 17, 1906. No. 77007 N.

Precipitates.

The Production of High-Grade Gold Bullion from Zinc-box Precipitates. C. J. Morris. Shows what can be done successfully, on a rather small scale, at a mine struggling to pay its way on a very low-grade ore. 1800 w. Inst of Min & Met—April 19, 1906. No. 76998 N.

Production.

Increased Production of Gold. R. W. Barrell. Discussing the effect increased production will have on the mining industry, and on the purchasing value of gold. 1800 w. Mines & Min—May, 1806: No. 76512 C.

Prospecting Shaft.

Notes on a Prospecting Shaft in the Goldfield District, Goldfield, Nevada. Edgar A. Collins. Describes the deposits and methods of mining and extraction, showing an unusual production. 1000 w. Inst of Min & Met—April 19, 1906. No. 76999 N.

Queensland.

Gold Deposits near Mount Ubi, West of the Blackall Range. B. Dunstan. Gives map and description of the auriferous country on Walli and Chinaman's creeks. 1500 w. Queens Gov Min Jour—March 15, 1906. No. 76430 B.

Separation.

The Separation of Gold in Antimony Ores. F. H. Mason. Gives an analysis showing the nature of the ore treated, and explains experimental investigations made, and the process finally pronounced successful. 3800 w. Min & Sci Pr—April 28, 1906. No. 76638.

Tin-Stone.

The Assay of Auriferous Tin-stone. C. O. Bannister. Read before the Inst. of Min. & Met. Reports results obtained by the author in comparing results obtained by different methods of assaying for gold in alluvial tin deposits. 1500 w. Min Jour—April 21, 1906. No. 76444 A.

IRON AND STEEL.

Blast Furnaces.

The Use of Oxygen in Removing Furnace Obstructions. C. de Schwarz. Read before the Iron & Steel Inst. Describes the application of compressed oxygen for the opening of closed tap-holes or tuyeres. 2000 w. Ir Age—May 17, 1906. No. 76674.

Cast Iron.

See Mechanical Engineering, Materials.

Compression.

Compression of Steel Ingots in the Mould. A. G. Capron. Explains the construction of the ingot moulds and press, stating the advantages obtained by the use of this system. Ills. 1500 w. Ir & St Inst—May, 1906. No. 76914 N.

Dry-Air Blast.

A Digest of the Criticisms of Gayley's Dry Air Blast Process. F. A. Wilcox. 5600 w. Ir & Coal Trds Rev—May 11, 1906. No. 76924 A.

Ferro-Manganese.

The Preparation of Carbon. Free Ferro-Manganese. E. G. Ll. Roberts, and E. A. Wraight. Abstract report of research work with ferro-manganese and the efforts made to deprive this alloy of its carbon. 3300 w. Ir & Coal Trds Rev —May 11, 1906. No. 76923 A.

Iron Ore.

The Ironstone of Mount Lucy, Chillagoe District. B. Dunstan. Geological survey report, describing the deposits in Queensland. Ills. 1000 w. Queens Gov Min Jour—March 15, 1906. No. 76429 B.

Magnetite.

Magnetite Deposits and Mining at Mineville, N. Y. J. H. Granbery. An illustrated series of articles on the nature and origin of these deposits near Lake Champlain. 2200 w. Eng & Min Jour—May 12, 1906. Serial. 1st part. No. 76603.

Manganese.

Preliminary Note on the Influence of Manganese on Iron. J. O. Arnold and F. K. Knowles. Reports tests made by a number of investigators, giving the composition of the alloys, and explains the method of preparing alloys of nearly pure iron and manganese. 1500 w. Ir & St Inst—May, 1906. No. 76916 N.

Rolling Mills.

The Design of Rolling Mills. W. H. A. Robertson. Calls attention to points needing improvement. 1000 w. Ir & Coal Trds Rev—April 20, 1906. No. 76459 A.

Russia.

The Reconstruction of a Blast Furnace in Southern Russia (Modernes Umbau eines Hochofens in Sudrussland). Paul Thomas. With illustrations showing the workings at Kramatorskaia in the Government of Kharkoff, with details of the old and new furnaces. 2000 w. 1 plate. Stahl u Eisen—May 15, 1906. No. 76813 D.

Steel.

Crucible Steel. R. Barranger. Explains the manufacture of crucible steel, giving illustrated description of furnaces used, and information concerning the production. 4000 w. Foundry—May, 1906. No. 76710.

The Effect of Copper in Steel. F. H. Wigham. A report of research work, resulting in the conclusion that copper to the extent of 0.25 per cent is no disadvantage in the manufacture of the best classes of steel wire. 2000 w. Ir & St Inst—May, 1906. No. 76912 N.

Steel Sheets.

Brittleness and Blisters in Thin Steel Sheets. Edward F. Law. Reports an investigation of the causes, giving the conclusions from the results. Ills. 1800 w. Ir. & St Inst—May, 1906. No. 76913 N.

See also Mechanical Engineering, Materials.

MINING.

British Columbia.

A Reconnoissance into Tulameen, B. C. Horace F. Evans. Notes describing the country between Kamloops on the south, Thompson and the Tulameen River. The present number is introductory. 1500 w. Min Wld—May 26, 1906. Serial. 1st part. No. 76979.

Chains.

Chains. W. Macpherson. Read before the Nat. Assn. of Col. Mgrs. An illustrated paper on the use of chains at a colliery, their construction, upkeep, and the forms in which deterioration and decay manifest themselves. 4000 w. Ir & Coal Trds Rev—April 20, 1906. No. 76457 A.

Chert.

Chert Mining in England and Wales. Herbert L. Terry. Defines chert, and gives information about the occurrence, properties, and applications of the stone, and the methods followed in mining it. 4000 w. Inst of Min & Met—May 17, 1906. No. 77008 N.

Concentration.

The Sutton-Steele Process. R. C. Canby. Illustrations of the dry concentrating table and dielectric separator, and their operation. 1200 w. Eng & Min Jour—May 12, 1906. No. 76604.

Crusher.

A Very Large Gyratory Crusher. Illustrated description of a rock crusher, believed to be the largest in the world. 1400 w. Eng News—May 3, 1906. No. 76478.

Explosions.

Mine Explosions. J. T. Beard. Discusses the dangers and the factors that influence a mine explosion. 3500 w. Eng & Min Jour—May 19, 1906. No. 76731.

Faults.

The Fault System of Eastern Santa Eulalia. M. A. Knapp. Illustrated description of the geological formation of this silver-lead region in Mexico. 1200 w. Eng & Min Jour—May 26, 1906. No. 76968.

Hand-Drilling.

Methods of Hand-Drilling. W. R. Hulbert. Discusses the various systems of hand-drilling so as to give an idea of their relative merits. 900 w. Min & Sci Pr—May 12, 1906. No. 76722.

Head Frames.

Modern Types of Large Mine Head Frames. Bergassessor Brandi. Illustrated descriptions of types used at German mines. 2000 w. Min Mag—May, 1906. No. 76905 C.

Hydraulic Mining.

Hydraulic Mining in California. J. P. Hutchins. An account of this method of mining, the problems and difficulties, results, and present standing. Ills. 2800 w. Eng & Min Jour—May 19, 1906. No. 76729.

The Control of Hydraulic Mining in California by the Federal Government. Discussion of the paper by William W. Harts. 4500 w. Pr Am Soc of Civ Engrs—May, 1906. No. 76933 E.

Impact Screen.

On the Use of the Impact Screen in Tin-Dressing. J. H. Collins. Note on the first use of the impact screen in the United Kingdom, and, so far as known, its first application to tin-dressing. 400 w. Inst of Min & Met—April 19, 1906. No. 77000 N.

Lighting.

Acetylene Lighting in the Iron Mines of Lorraine (Azetylenbelenchtung beim Lothringischen Eisenerzbergbau). W. Serlo. With details of burners and portable acetylene generators, especially designed for mining use. 5000 w. Glückauf—April 28, 1906. No. 76823 D.

Lime Roasting.

The Huntington-Heberlein Process. Thomas Huntington and Ferdinand Heberlein. An account of this lime roasting process for the desulphurization of lead ores. Also editorial. 3500 w. Eng & Min Jour—May 26, 1906. No. 76970.

Matte.

A New Matte Separator. R. R. Hedley. Read before the Can. Min. Inst. Illustrates and describes a device invented by Henry Harris, successfully used in the Lead Smelting Works at Nelson, B. C. 1200 w. Can Min Rev—May, 1906. No. 76972 B.

New Mexico.

Mines and Reduction Works of the Comanche Mining and Smelting Company. Information concerning the enterprises of this company, especially in Grant and Socorro counties. 2000 w. Min Rept—May 3. 1906. Serial. 1st part. No. 76537.

New South Wales.

Mining at Broken Hill, New South Wales. Extracts from a speech by Mr. Harvey Patterson, explaining the conditions of mining. 2800 w. N Z Mines Rec—March 16, 1906. No. 76553 B.

Ore Deposits.

Ore Deposits and Their Distribution in Depth. Prof. John W. Gregory. Delivered before the Royal Inst. of Gt. Britain. Discusses the past, present, and future ore supply of the world. 1300 w. Min Jour—May 5, 1906. Serial. 1st part. No. 76658 A.

Perspective.

Perspective in Mining. J. Parke Channing. Address to the Engng. Soc. of Columbia Univ. Suggestions for young mining engineers. 4000 w. Min. Sci Pr —May 5, 1906. No. 76640.

Respirators.

The Chemistry and Mechanics of Respirator Life-Saving Appliances (Beiträge zur Chemie und Mechanik von Rettungsapparaten). M. Bamberger and F. Böck. A discussion of the reactions involved in the chemical regeneration of air for breathing, in connection with life-saving appliances for mines. 5000 w. Glückauf —May 12, 1906. No. 76826 D.

Rhodesia.

The Ancient Auriferous Conglomerates of Southern Rhodesia. J. W. Gregory. Discusses the genesis of the Rhodesian "banket," illustrating and describing samples taken. 6400 w. Inst of Min & Met—May 17, 1906. No. 77004 N.

Rock Drills.

A Carriage for Rock Drills. C. F. J. Galloway. Read before the South Wales Inst. of Engrs. An illustrated description of an application of the Brandt column, which is used in conjunction with drilling machines actuated by compressed air. 2500 w. Min Jour—April 28, 1906. Serial. 1st part. No. 76568 A.

Roasting.

Lime Roasting of Nickeliferous Matte. A. C. de Jongh. An acount of some experiments in working of nickel-copper matte. 700 w. Eng & Min Jour —April 28, 1906. No. 76396.

Safety Appliance.

The Undeutsch Safety Catch. Erminio Ferraris. Review of a book by Hermann Undeutsch, considering the rational construction of safety-catches on cages, and all matters relating to their efficiency and action. Ills. 3000 w. Eng & Min Jour—May 26, 1906. No. 76969.

Sampling.

Sampling with a Churn-Drill. Matt. W. Alderson. An illustrated article describing this method of sampling a large surface showing. 1000 w. Min Sci Pr—May 19, 1906. No. 76982.

Shaft Sinking.

An account of Sinking and Tubbing at the Methley Junction Colliery, with a Description of a Cast Iron Dam to Resist an Outburst of Water. Isaac Hodges. Abstract of a paper read before the Midland Co.'s Inst. of Engrs. 3500 w. Col Guard—April 20, 1906. No. 76447 A.

Applications of the Freezing Process to the Deepening of Two Shafts at Limburg, Holland (Die Anwendung des Gefrierverfahrens beim Abteufen zweier Schächte auf der Höllandischen Staatsgrube B, in der Provinz Limburg). H. Joosten. Describing the successful sinking of shafts 120 meters deep through quicksand by the use of the freezing process. 4000 w. Glückauf—May 12, 1906. No. 76825 D.

Shaft Timbers. Thomas Varcoe. Illustrates and describes methods of framing shaft timbers and making splices in the wall plates for very long shafts. 700 w. Min Jour—May 12, 1906. No. 76760 A.

The Application of Direct Cementation in Shaft Sinking. C. Dinoire. Abstract of a paper read before the Société de l'Industrie Minéral. Reports the application of direct cementation to a shaft where the water flow caused difficulties. 3500 w. Min Jour—April 21, 1906. No. 76443 A.

Stopes.

Handling Ore in Stopes. D. T. Williams. Abstract of a paper in the *Jour. of the Transvaal Inst. of Mech. Engrs.* An explanation of the difficulties and description of the mechanical devices introduced. 2200 w. Eng & Min Jour—May 5, 1906. No. 76545.

The Detailed Mapping of Stoping Areas. H. R. Sleeman. Deals with the graphic representation, in their true dimensions, of blocked-out ore reserves, considering the question solely in regard to inclined reefs. 2500 w. Inst of Min & Met—Feb. 15, 1906. No. 76993 N.

Timbering.

The Impregnation of Mining Timber (Ueber die Imprägnierung von Grubenhölzern). F. Seidenschnur. Discussing the importance of using preservatives for wood used for timbering mines, with photographs showing the increase in durability. 1800 w. Glückauf—May 5, 1906. No. 76824 D.

Underground Timbering. R. B. Nickerson. Describes methods of timbering heavy mines, methods of taking the measures for timbers underground, etc. 2000 w. Min & Sci Pr—May 19, 1906. No. 76983.

Ventilation.

Ventilation and Sanitation of Mines. Extracts from the report of the West Australian Royal Commission on the use of compressed air for ventilating purposes. 3500 w. Queens Gov Min Jour—April 18, 1906. No. 76986 B.

Winding.

85-Horse-Power Electric Winding Engine. Illustrates and describes an engine built for the Lens Colliery Company, in France. 1200 w. Engng—May 18, 1906. No. 77015 A.

Electric Winding. W. C. Mountain. A reply to published discussions and conclusions on a recent paper by the writer dealing with this subject. 1500 w. Ir & Coal Trds Rev—April 27, 1906. No. 76584 A.

MISCELLANY.

Arizona.

Sketch of the Geology and Ore Deposits of the Cherry Creek District, Arizona. John A. Reid. Considers the location, topography and geology of this interesting region, and the peculiar ore deposition. 6500 w. Ec Geol—March, 1906. No. 76944 D.

Asbestos.

The Mining Manufacture and Uses of Asbestos. J. Alfred Fisher. An illustrated article giving information concerning this mineral, especially its use as a covering for boilers, pipes, etc. 3700 w. Tram & Ry Wld—May 11, 1906. No. 76928 B.

Asphalt Veins.

The Formation of Asphalt Veins. George Homans Eldridge. The distribution, nature and origin of the fissures, dimensions of the veins, and relation to the enclosing strata are considered; comparison with metalliferous veins; the origin of the material, and the manner of its introduction. 3000 w. Ec Geol—March, 1906. No. 76945 D.

Diamonds.

Diamond Industry at Brazil. Arthur de Belmont Information concerning the localities where diamonds are found, their size, value, and the associated minerals. Ills. 1000 w. Min Wld—May 5, 1906. No. 76542.

Gems.

The Gems of Ceylon, Their Form of Occurrence and Methods of Extraction. Ralph Stokes. An interesting account of this industry, describing the deposits, and the methods. Ills. 3000 w. Min Wld—April 28, 1906. No. 76408.

Graphite.

Graphite—Its Occurrence and Uses. Charles C. Schnatterbeck. Discusses the occurrence, mining and refining, uses and values of this mineral. 1800 w. Min Wld—May 12, 1906. No. 76642.

Lead.

An Unique Lead Deposit. R. D. O. Johnson. Describes a deposit in Missouri, a mineralized clay bed, and the method of mining. 1200 w. Eng & Min Jour—April 28, 1906. No. 76397. -

Visit to a Cornish Lead Mine and Experiences with a Man Engine. A. Lakes. Describes an unusual method of raising and lowering the men in the mines. 700 w. Min Rept—May 3, 1906. No. 76539.

Lead and Zinc.

Mississippi Valley Lead and Zinc District. Ralph E. Davis. Describes the deposits in Wisconsin, Illinois, and Iowa, the geology, origin of the ores etc. Ills. 3000 w. Min Wld—May 5, 1906. No. 76540.

Metallurgy.

The New Metallurgy. G. A. Denny and H. S. Denny. Considers the metallurgical question of the Witwatersrand, discussing the results obtained at the New Goch and the Meyer & Charlton mines, where the new departures have been put into practice. 5500 w. Min Jour—May 19, 1906. No. 77011 A.

Unsolved Problems in Metallurgy. Robert Abbott Hadfield. The Inst. of Civ. Engrs.—14th "James Forrest Lecture." Deals chiefly with iron and its alloys. 2500 w. Engr, Lond—May 4, 1906. Serial. 1st part. No. 76665 A.

Mica.

India Mica Industry. Ralph Stokes. An illustrated account of the Madras or Nellore mica field and its development. 2500 w. Min Wld—May 19, 1906. No. 76719.

Monazite.

Monazite Sand. C. Richard Böhm. Abstract of a paper in *Chemische Industrie*. Where known deposits are located, the method of working, exploitation, etc. 1200 w. Eng & Min Jour—May 5, 1906. No. 76543.

Nigeria.

The Mineral Survey of Nigeria. Information from the reports by Prof. Dunstan, on The Mineral Survey of Nigeria. The minerals found are given. 1200 w. Engr, Lond—May 11, 1906. No. 76766 A.

Phosphate.

Florida Pebble-Phosphate Mining. John Bannon. Describes the processes and methods of the phosphate mining industry. 2500 w. Mfrs Rec—May 3, 1906. Serial. 1st part. No. 76480.

Platinum.

How to Pan Platinum. Dennis H. Stovall. Suggestions from the experience of W. J. Wimer. 700 w. Min Wld—April 28, 1906. No. 76409.

Tin.

Tin. The Famine in Tin. Editorial discussion of the increase in price, and the falling off of the supply, and the future outlook, mining localities, etc. 2000 w. Engng—May 18, 1906. No. 77016 A.

The Tin Deposits of Alaska. Abstract of a report by Frank L. Hess, who visited and examined the prospects and development work in the York region of Alaska. 2800 w. Ir Age—May 31, 1906. No. 77030.

The Vulcan Tin Mine, North Queensland. Gives the history of a mine which has beaten the record of any lode tin mine in the world. 2200 w. Min Jour—May 19, 1906. No. 77010 A.

Uranium.

Uranium. Victor Blanc, in *Western Chemist and Metallurgist.* Describes the metal and its properties, its occurrence, determination, etc. 2400 w. Aust Min Stand—March 28, 1906. No. 76554 B.

Zinc.

Spelter Statistics for 1906. W. R. Ingalls. Statistics of this industry in the United States, showing where the ore was produced and where consumed. 3500 w. Eng & Min Jour—May 12, 1906. No. 76608.

The Lungwitz Process of Zinc Smelting. Fred W. Gordon. Describes a furnace recently put into operation at Warren, N. H., especially designed to meet the requirements of this process, and the problems in connection with its operation. 3000 w. Eng & Min Jour—April 28, 1906. Serial. 1st part. No. 76398.

Zinc Mining in New Mexico. R. W. Haddon. Describes the deposits of the Magdalena range, giving cross section, and reporting development. 1000 w. Eng & Min Jour—May 5, 1906. No. 76544.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Railroads.

The Relations of the Railroads to the Public. R. C. Richards. Address before the Trans. Assn. of Milwaukee. Discusses things essential, the investigation of claims and complaints, improvements needed, etc. 2000 w. R R Gaz—May 11, 1906. No. 76612.

Tablet Exchange.

Whitaker's Electric Train Tablet Exchanger. Briefly outlines the mechanical and manual apparatus which has been in use, and gives an illustrated description of the new pattern invented by Mr. A. Whitaker. 1800 w. Engng—April 27, 1906. No. 76571 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brakebeams and Foundation Rigging—The Requirements from the Standpoint of Safety and Emergency. Edward B. Leigh. Presents facts showing that foundation rigging and "emergency" service, should have immediate attention and treatment. 2800 w. Ry Age—May 25, 1906. No. 76984.

Brake Tests Made at West Seneca on the "Lake Shore and Michigan Southern Railway." Report of tests made on the Westinghouse brake known as the quick-service brake. 3000 w. Bul Int Ry Cong—April, 1906. No. 76954 E.

Comparative Test of Large Locomotive Air Pumps. Reports a comparative test of the new Westinghouse compound and the New York No. 5 duplex pumps, made by the L. S. & M. S. Ry. 1800 w. Ry Age—May 18, 1906. No. 76717.

New S. F. Brake Valve. Illustrated description. 800 w. Ry & Loc Engng—June, 1906. No. 77108 C.

New Westinghouse K Triple Valve. Illustrated detailed description of the quick service triple valve and its operation. 1000 w. Ry & Loc Engng—June, 1906. No. 77109 C.

Type H. Automatic Brake Valve. Illustrated detailed description. 1700 w. Ry & Loc Engng—June, 1906. No. 77107C.

Cars.

Rapid Railway-Carriage Building. An illustrated account of work carried out in India at the Parel workshops of the Great Indian Peninsula Railway Company. 800 w. Engng—May 18, 1906. No. 77017 A.

Steel Flat-Cars for Specially Heavy Loads. Illustrates and describes recently built cars, designed to carry heavy castings and peculiar designs. The 100-ton car for the Allis-Chalmers Co.; 87-ton and 60-ton cars: Pennsylvania R. R.; and 60-ton car: General Electric Co. are considered. 2200 w. Eng News—May 24, 1906. No. 76779.

Steel Rolling Stock. George Harrison Sheffield. Abstract of a paper read before the Tram. & Lgt. Rys. Assn. Does not consider a combination of steel and timber desirable, reports condition of all-steel cars in long service, and discusses changes and improvements in rolling stock. 3300 w. Elect'n, Lond—April 27, No. 76567 A.

Very Heavy Capacity Flat Car. Illustrated description of a novel freight car design, built at the C. M. & St. P. Ry. shops in West Milwaukee for the Allis-Chalmers Co. It is designed for a load capacity of 100 tons, with a permissible 10 per cent overload. 1200 w. Ry & Engng Rev—April 28, 1906. No. 76403.

Liquid Fuel.

Petroleum Fuel in Locomotives in the Tehuantepec National Railroad of Mexico. Louis Greaven. Gives the results obtained by the use of liquid fuel for one year. Ills. 4000 w. Inst of Mech Engrs—March 16, 1906. No. 76666 N.

Locomotive Boiler.

Brotan Locomotive Boiler with Water Tube Firebox. Illustrated detailed description of a boiler being introduced on several foreign roads. It was designed to obviate the difficulty found with copper fireboxes and staybolts, especially when used for high pressures. 1600 w. Ry Age—May 4, 1906. No. 76535.

Locomotives.

A Comparative Test Between a Simple and Compound Locomotive. A thesis submitted for the degree of Bachelor of Science in Mechanical Engineering, University of Wisconsin. Describes tests made. Plates. Discussion. 14800 w. Pro W Ry Club—April 17, 1906. No. 76693 C.

British Locomotives in 1905. Charles Rous-Marten. A review of the designs and work. Ills. 6800 w. Bul Int Ry Cong—April, 1906. No. 76949 E.

Comparison of the Wear of Wheel Tires of Locomotives with inside and with Outside Cylinders. O. Busse. Showing the advantages of inside cylinders. Tables and Ills. 1300 w. Bul Int Ry Cong—April, 1906. No. 76951 E.

Compound Locomotives. G. R. Sisterston. Considers the things upon which the success of compound systems depend, and describes a form of this system in which there are four equal cylinders, one high and there low-pressure. 2000 w. Engr, Lond—April 27, 1906. No. 76577 A.

Conversion of the Great Eastern Decopod. Reviews the history of this English locomotive, and gives an account of the use made of it. 1200 w. Engr, Lond—April 20, 1906. No. 76450 A.

Locomotives with Special Valve Gears (Lokomotiven mit Ventilsteurerung). E. Metzeltin. Describing special gears for locomotives using piston, Corliss, and similar valves, with especial reference to the locomotives of the Hanover Machine Works. Serial. Part I. 7500 w. Zeitschr d Ver Deutscher Ing—April 28, 1906. No. 76801 D.

Norfolk & Western 4-6-2 Locomotive. Illustrates and describes the principal features of interest. 400 w. Ry Age—May 4, 1906. No. 76534.

Note on the Calculation of the Loads Hauled by Locomotives and on the Determination of the Time Required for Running in Ordinary Service. O. Busse. 2000 w. Tables. Bul Int Ry Cong—April, 1906. No. 76952 E.

Standardizing Locomotive Equipment. Describes the Standard locomotive parts adopted by the Canadian Pacific Railway. 1200 w. Am Engr & R R Jour—April, 1906. Serial. 1st part. No. 76466 C.

Superheating.

Locomotive Superheaters — Practical Difficulties in the Use of Superheated Steam. Remarks recently made by W. F. M. Goss, reviewing the early and recent developments in the use of superheated steam. 2000 w Sci Am Sup—May 19, 1906. No. 76689.

Superheated Steam on the Canadian Pacific Railway. H. H. Vaughan. Describes the progress made during the last year in the application of superheated steam to locomotives on the Canadian Pacific Railway, discussing the results. Also general discussion. Ills. 12400 w. Pro N Y R R Club—April 20, 1906. No. 76794.

Superheated Steam on the Canadian Pacific Railway. Editorial review of the paper presented by H. H. Vaughan before the N. Y. R. R. Club. 3000 w. Am Engr & R R Jour—May, 1906. No. 76468 C.

Ten-Wheel Coupled Locomotive for Argentina. Two-page engraving and illustrated description of details of this interesting engine. 1000 w. Engng—May 18, 1906. No. 77012 A.

Train Lighting.

The L'Hoest and Pieper System of Electric Train Lighting (Die Elektrische Zugbeleuchtung von L'Hoest und Pieper). E. Wikander. A steam dynamo on the locomotive associated with a storage battery, furnishes the current for the train. 1000 w. Glasers Annalen—May 15, 1906. No. 76819 D.

The Lighting of Railway Carriages with Incandescent Gas Burners (Gasglühlichtbeleuchtung der Eisenbahnwagen). H. Gerdes. With illustrations of direct and inverted mantle burners as used in England, France, and Germany, with especial reference to the Pintsch incandescent light. A table of photometric tests is given. 3500 w. Glasers Annalen—May 1, 1906. No. 76830 D.

Trucks.

Motor Trucks for the New York Central Electric Service. Illustrated description of the truck adopted for the electric suburban cars, which is a departure from any type of motor truck heretofore used. 1800 w. St. Ry Jour—April 28, 1906. No. 76412 C.

Wheels.

Solid Rolled Steel Car Wheels and Tires. Peter Eyermann. Reviews the development of iron and steel wheels, the methods of manufacture, describing plants and the various types made in Europe and America. Ills. 5000 w. Ir & St Inst—May, 1906. No. 76915 N.

NEW PROJECTS.

Central Asia.

Russian Railway Schemes in Central Asia (Eisenbahnbau und Eisenbahnpläne in Mittelasien). F. Thiess. With map of the Orenburg-Tashkend railway plans, showing the political and commercial relations of the line to Persia, Turkestan, and India. Map. 2000 w. Glasers Annalen—May 15, 1906. No. 76818 D.

China.

What Railroads May Do for China. Eliot Blackwelder. Describes the methods of transportation used by the Chinese, which have remained unchanged for many generations. Ills. 2200 w. Wis Engr—June, 1906. No. 76698 D.

Moffat Road.

The Denver, Northwestern and Pacific. This new road the construction of which was brought about by David H. Moffat, is generally known as the Moffat road. Describes recent work, and the country through which the road passes. Ills. 2500 w. R R Gaz—May 18, 1906. No. 76746.

Philippines.

The Plans and Organization for the Philippine Railway System. Brief account of the plans for the proposed railway system. 1000 w. Eng News—May 10, 1906. No. 76621.

Transportation Systems and Projects in the Philippines. Lawrence E. Bennett. Mr. Bennett's second article discusses personal experiences on reconnaissance surveys in connection with railroad construction in the Visayan islands. 3500 w. Engineering Magazine—June, 1906. No. 76872 B.

PERMANENT WAY AND BUILDINGS.

Coaling.

Mechanical Coaling Plants for Locomotives (Mechanische Lokomotiobekohlungsanlagen). E. Harprecht. An illustrated discussion of modern conveyors, coaling bins, and coal handling appliances for railroads, with details from American and German practice. Serial. Part I. 3000 w. 2 plates. Glasers Annalen—May 15, 1906. No. 76817 D.

Culverts.

Areas of Waterways for Railroad Culverts and Bridges. George H. Bremner. Also discussion by James Dun, J. W. Alvord, Louis Kingman and others. Explains the method used by the writer after a number of years of experience. 21500 w. Jour W Soc of Engrs—April, 1906. No. 76929 D.

The Reinforced Concrete Beam Culvert: An Inefficient Structure. Daniel B. Lutin. Arguments unfavorable to the use of beams. Ills. 2000 w. Eng News—May 24, 1906. No. 76778.

Grades.

Ruling Grades on the Transcontinental Lines. Profiles and tables of the Harriman lines and Northern Pacific, with revised tables of ruling grades on A., T. & St. F., and the Can. Pacific. 600 w. R R Gaz—May 4, 1906. No. 76495.

Light Railway.

Light Railway on Ayrshire Seaboard. Illustrates and describes the Maidens and Dunure Light Railway, which overcame considerable engineering difficulties in its construction. It has 65 bridges, 20 viaducts, 6 culverts, and the entire length of the railway is only 19½ miles. 900 w. Engr, Lond—May 18, 1906. No. 77021 A.

Panama.

Increased Terminal Facilities for the Panama Railway. A brief account of the steps being taken to provide ample rail and water facilities for the handling of both through and canal traffic. 500 w. Eng News—May 24, 1906. No. 76780.

Rails.

The First T Rail? Engraving and account reproduced from the Morton Memorial Volume, edited by Prof. F. de R. Furman, of Stevens Inst., Hoboken, N. J. 700 w. R R Gaz—May 11, 1906. No. 76613.

Shop Efficiency.

Improving Railroad Shop Efficiency. Charles Coleman. Considers reduction in the cost of repairs without impairing the efficiency of the locomotive. 1000 w. Am Engr & R R Jour—May, 1906. No. 76467 C.

Signals.

Block Switch and Signal Systems (Blockapparate und Weichenverschlüsse). Dr. A. Tobler. Describing especially the electric block system of Siemens & Halske, as used in Vienna. Two articles. 4000 w. Schweiz Bauzeitung—April 21, 28, 1906. No. 76831 each B.

The Upward Indication of the Semaphore Arm. L. R. Clausen. Read before the Ry. Sig. Assn. Favoring the change from the downward to the upward indication for proceed, giving arguments. Ills. 2000 w. Ry Age—May 4, 1906. No. 76536.

Union All-Electric Interlocking at Elsmere Junction. Illustrates and describes an interlocking plant installed near Wilmington, Del. 2500 w. R R Gaz—May 11, 1906. No. 76515.

Stations.

New York Central Passenger Station at Schenectady. Outlines improvements in this city to eliminate grade crossings and describes the fine new station building. Plans. 1800 w. Ry Age—April 27, 1906. No. 76402.

Pennsylvania Railroad's Terminal Station, New York City. Illustrated description of the proposed design. 1600 w. Sci Am—May 26, 1906. No. 76788.

The Pennsylvania Railroad's Extension to New York and Long Island. Plan, section, and illustrations of the new station in New York, with description. 2000 w. R R Gaz—May 25, 1906. No. 76966.

The Pennsylvania Railroad Passenger Station in New York City. Description, with illustrations, of the fine station to be built in New York City. 1500 w. Eng News—May 24, 1906. No. 76776.

Ties.

A Review of the Railway Tie Situation. Discusses the diminution in the sources of suppl· tie-preserving, use of steel and concrete ties, spacing, size, life, etc. 3000 w. Eng News—May 3, 1906. No. 76479.

Tunnels.

See Civil Engineering, Combustion.

Yards.

New East Bottoms Yard of the Missouri Pacific at Kansas City. Plan and description of the enlargement and complete rearrangement of this yard. 1200 w. R R Gaz—May 11, 1906. No. 76611.

TRAFFIC.

Coal.

Great Northern Railway Coal Traffic. An illustrated account of the heavy traffic handled by this railway. 1500 w. Ir & Coal Trds Rev—May 18, 1906. No. 77024 A.

Earnings.

New York Central & Hudson River. Reviews this road for the past year, showing great growth in earnings, large progress in the work of electrifying the New York terminal, additional electric properties acquired, and general improvements. 2000 w. R R Gaz—May 4, 1906. No. 76493.

Rates.

The Railroad Rate Bill. Full reproduction of the Hepburn bill in the form in which it went into the hands of the committee. 7000 w. R R Gaz—May 25, 1906. No. 76967.

The Standard Oil Co.'s Low Railroad Rates. Gives extracts from Mr. Garfield's report in regard to discriminations made in favor of the Standard Oil Co., and some of the replies from the railroads. 1500 w. R R Gaz—May 11, 1906. No. 76614.

STREET AND ELECTRIC RAILWAYS.

Alabama.

Car House, Shops and Shop Practices at Birmingham, Ala. An illustrated detailed description of the car-housing and repair plant and its equipment. 3300 w. St. Ry Jour—May 5, 1906. No. 76529 C.

Alternating Current.

Alternating Current Track Circuits in the New York Subway. J. M. Waldron. Read before the Ry. Sig. Assn. at N. Y. An interesting description, with diagrams, showing the remarkable efficiency of this system of automatic signals. 1400 w. R R Gaz—May 11, 1906. No. 76610.

Australia.

The Freemantle (Australia) Municipal Tramways. Illustrated detailed description of the only municipal tramway in Australia. 3000 w. St Ry Jour—May 5, 1906. No. 76530 C.

Cars.

The New Cars of the South Side Elevated Railway, Chicago, and Their Equipment. Illustrated detailed description of new cars, seventy having just been built, and of their equipment. 3000 w. St Ry Jour—May 19, 1906. No. 76725 C.

The New Closed Car Adopted by the Schenectady Railway Company. An illustrated description of the interesting features of cars representing the most advanced practice. 1300 w. St Ry Jour —May 5, 1906. No. 76531 C.

Earnings.

An Aggregate of Electric Railway Earnings. Abstract of an article in the *Commercial and Financial Chronicle,* giving as far as possible a total of the gross and net earnings of all important street and electric railways in the United States. 1200 w. R R Gaz—May 4, 1906. No. 76494.

Freight.

Freight Handling Practice on Electric Railways. An illustrated article describing some of the methods of handling the business, and giving information of interest. 8000 w. Ry & Engng Rev—May 12, 1906. No. 76635.

Gasoline Cars.

The Gasoline Car for Interurban Service. F. W. Hild. Read at convention of the Iowa St. & Int. Ry. Assn. Investigates and compares the factors essential to the success of self-propelled cars, concluding that these cars will find a useful field quite distinct from that served by the electric system. Also editorial. 6500 w. St Ry Jour—May 5, 1906. No. 76532 C.

Grades.

The Story of the Galveston Grade Raising—From the Street Railway Point of View. H. S. Cooper. An illustrated article describing grade raising under very adverse conditions. 4000 w. St Ry Jour—May 12, 1906. No. 76644 C.

Improvements.

Improvements of the Brooklyn Rapid Transit Company. Illustrates and describes interesting work in connection with the reconstruction of this property. 1600 w. Ry Age—May 18, 1906. No. 76716.

Interurban.

Extensions and Improvements of the Terre Haute Traction & Light Company. An illustrated article describing new lines, features of the high-tension feeder system, and other improvements. 2000 w. St Ry Jour—April 28, 1906. No. 76410 C.

Line Construction.

New Material for Catenary Work. Illustrated description of a new method of construction now under trial, reporting tests. 1000 w. St Ry Jour—May 26, 1906. No. 76965 C.

London.

First London Tramway across the Thames. Illustrated description of the Vauxhall-Victoria tramway. 2200 w. Tram & Ry Wld—May 19, 1906. No. 76927 B.

Main Line.

Electrification of the West Shore Railroad Between Utica and Syracuse. Maps and description of the changes being made in this section, and the service to be rendered. Also editorial. 2500 w. St Ry Jour—May 19, 1906. No. 76726 C.

Missouri.

The St. Francois County Electric Railway. An illustrated description of a very successful line, explaining its peculiar location, and the reasons for its exceptional earning capacity. 3000 w. St Ry Jour—May 26, 1906. No. 76963 C.

Puget Sound.

The Puget Sound Electric Railway. Map and illustrated description of a third-rail line 36.5 miles long, connecting Seattle and Tacoma 1800 w. Ry Age—May 11, 1906. No. 76634.

San Francisco.

Street Railway Situation in San Francisco. An illustrated article explaining some changes proposed in reconstructing the lines destroyed by the .earthquake and fire. 1800 w. St Ry Jour—May 19, 1906. No. 76727 C.

Single-Phase.

Single-Phase Locomotives and Motor Cars in Bavaria and Sweden. Frank C. Perkins. Illustrations of the locomotives used, and description of the electrical equipment and other interesting features. 1500 w. Sci Am Sup—May 5, 1906. No. 76501.

Single-Phase Railway for the Milan Exhibition, 1906. E. Fumero. Abstract translation from *L'Electricita*. Gives the chief features of this exhibition installation, which connects the two sites. Ills. 2000 w. Elect'n, Lond—May 11, 1906. No. 76757 A.

The Development of the Westinghouse Company's Single-Phase Railway System. An interesting brief review of the development. 1400 w. Elec Wld—April 28, 1906. No. 76593.

Stray Currents.

See Civil Engineering, Water Supply.

Sub-Stations.

Railway Sub-Station Design, Capacity and Location. Sydney Woodfield. Outlines a few considerations in regard to converter sub-stations, discussing types. 2700 w. Elec Rev, Lond—April 20, 1906. No. 76438 A.

Subways.

The Mersey Tunnel and the London Metropolitan Railway Electrifications. H. L. Kirker. In the first case the change from steam to electricity was made in a few hours; in the second the change-over was made gradually. This article shows the wisdom of the latter plan. 2000 w. Elec Jour—May, 1906. Serial. 1st part. No. 76702.

Subway Temperatures.

Causes for the Elevation in Temperature in Underground Railways (Die Gründe für die Temperaturerhöhungen in Untergrundbahnen). H. Kayser. A discussion of the extent to which the conversion of electrical energy acts to heat the atmosphere of underground railways; with data from London Paris, and New York. 5000 w. Gesundheit's-Ingenieur—May 12, 1906. No. 76843 D.

Switzerland.

An Interesting Swiss Electric Road. C. L. Durand. Brief illustrated description of the Fribourg-Morat-Anet single-phase line near Lake Neuchatel. 1500 w. Elec Rev, N Y—May 26, 1906. No. 76962.

Symbols.

Standard Symbols for Electric Railway Plans (Sicherheitsvorschriften für Elektrische Bahnanlagen). A report upon standard symbols by the German Electrotechnical Society. 7500 w. Elektrotech Zeitschr—May 17, 1906. No. 76861 B.

Three-Phase.

Berthoud-Thoune, Switzerland, Three-Phase Electric Road. C. L. Durand. Describes this three-phase electric road, giving several views of the locomotive used. 2800 w. Elec Rev, N Y—May 5, 1906. No. 76507.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves readv to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Radioactivity.

The Electrical Nature of Matter and Radioactivity. By Harry C. Jones. Size 5½ in. by 8 in., pp. x, 212. Price $2.00. New York: D. Van Nostrand Company.

A general study of the modern theory of the electron and its relation to the constitution of matter, expressed in plain, clear language, intelligible to the general reader. For those to whom the writings of J. J. Thomson and of Rutherford are difficult reading this modest work is to be commended, and the excellent reception which its chapters received as they appeared in the pages of the *Electrical Review* of New York, gives little doubt of the success of this reprint in book form.

The development of the study of radioactivity, and the discovery and separation of the radium salts opened a new chapter in investigations into the nature of matter, and this portion of the subject is treated by Mr. Jones in a manner at once clear and correct.

The student and general reader who desires to inform himself about these latest developments in the researches of the physicist and the physical chemist will find this little book at once scientifically correct and wholly readable and interesting, and it should find a wide acceptance in the wide circle to which it appeals.

Refrigeration.

Modern Refrigerating Machinery. Translated from the German of Professor Hans Lorenz by Thomas H. Pope, with chapters on American practice by H. M. Haven and F. W. Dean. Size 6 in. by 9 in., pp. x, 396. Price $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This is a distinctly practical work, dealing with the fundamental principles of mechanical refrigeration in brief introduction, followed by descriptions of the construction of actual machines and their operation. Dr. Lorenz naturally deals with apparatus of continental design and make, and the majority of his references are to the work of Pictet and of Linde, to whom engineers in all parts of the world are ready to do honor. The added matter, due to Messrs. Haven and Dean, deals with distinctively American appliances, and includes some excellent diagrams showing in schematic arrangement the methods of direct and indirect expansion. The mechanism of American ammonia compression machines of leading builders is given in illustration, and space is also given to machines of the absorption type. It is well understood that ammonia machines have altogether replaced compressed-air machines for general service, but it should be remembered that the so-called "dense-air" machine of Mr. Leicester Allen still retains its position as the best type available for naval service, where, in long cruises in tropical waters, absolute independence of any external source of supply is essential.

The book contains some useful tables, and should form a valuable reference treatise for an important department of modern industry.

Tunnelling.

Tunnel Shields and the Use of Compressed Air in Subaqueous Works. By William Charles Copperthwaite. Size 8 in. by 11 in.; pp. xvi, 390; price, 31s. 6d.; $9.00. London: Archibald Constable & Co. New York: D. Van Nostrand Company.

With the increasing use of tunnels instead of bridges for the crossing of waterways by railways and other ways of communication there has been a revival of interest in methods of construction of such works, and hence the portly volume of Mr. Copperthwaite is timely.

It is generally understood that the use of the shield in tunnelling is due to the elder Brunel, and indeed, Mr. Copperthwaite states that the Brunel patent of 1818 "covers every subsequent development in the construction and working of tunnel shields." The progress of mechanical science since this first conception of the true method of tunnelling through earth has placed many additional resources in the hands of the engineer, and it is principally of these later methods that the present work has to deal.

After reviewing the early history of shield tunnelling, from 1818 down to 1880, the author proceeds to discuss the use of compressed air in tunnelling, together with the development of cast-iron linings for tunnel work. The balance of the work is practically a descriptive account of the use of the shield in various departments of tunnelling work, including its employment in London clay, in water-bearing strata, and the construction of masonry-lined tunnels. These chapters are followed by an account of tunnelling works carried on with the use of the shield, together with data concerning the cost of tunnelling, based upon the records of executed works.

The great value of the book resides in its collection of fully illustrated descriptions of actual tunnel works constructed with the use of various forms of shields, these including such modern structures as the City and South London railway, the Glasgow harbor tunnels, the Hudson river tunnel, the St. Clair river tunnel, the Vyrnwy acqueduct, the Boston subway, the Paris Métropolitain, and similar modern works.

The data relating to costs are derived from recent works, including the Mersey tunnel, the Kingsway subway, and the work at Glasgow and the Sarnia tunnel under the St. Clair river. In an appendix there is given a chronological list of events relating to shield tunnelling, followed by a list of English patents from 1818 to 1904.

The book is a most valuable record of data of recent construction in tunnelling, and will doubtless become a standard of reference for engineers engaged in this increasing line of work. It is hardly to be expected that the book would contain information about the tunnels at present under construction for the Pennsylvania railroad under the Hudson river and the East River at New York, but information about these latest structures is attainable in the current technical journals, so that the earlier work can readily be supplemented and brought down to date in this manner. Otherwise it forms a valuable account of an important department of engineering work, and one which is doubtless destined to possess increasing interest as surface lines of municipal communication are replaced by underground railways. The congestion which is destined to increase in many of the great cities can only be met by the construction of subways, to which electric traction is especially adapted, this means of relief also including release from the difficulties involved in surface hauling, so that tunnel construction appears to be a department of engineering work which is destined to grow in importance in the near future, and the present work is especially timely in this respect.

Turbines.

Steam Turbine Engineering. By T. Stevens and H. M. Hobart. Size 6 in. by 9 in.; pp. x, 814. Price, 21s., $6.50. London: Whittaker & Co., New York: The Macmillan Company.

The great interest which is felt in the development of the steam turbine appears in the growing mass of literature concerning its design and construction. The earlier accounts of the modern machines appeared in the pages of the technical journals, followed by the books of Stodola, Neilson, Gentsch, and others, and now we have the present volume, which is of interest and value mainly because of the very full account which it gives of actual installations, their performances, and their recorded operative costs. Other authors have gone deeply into the thermodynamics of the turbine, the proportions of nozzles, the form of buckets, and the constructive details of various parts of the machine, but the authors of this book rightly believe that there is room for a treatise of the subject from the standpoint of the purchaser and user. The former is deeply concerned in the matter of first costs, while the latter must consider both steam consumption and maintenance. Both are vitally interested in methods of estimating the relative total costs and economy of complete projects in which, on the one hand, steam turbines, and on the other hand, other types of prime movers are employed. It is these aspects of the question which are often overlooked by designers and builders of such machines, and hence a work devoted to this side of the subject is to be welcomed.

The book starts in at once with a discussion of installation cost data, followed by chapters devoted to the leading types, with illustrations of construction, diagrams of performance, and data of operative costs. Comparisons are made of the performance of turbine and piston-engine plants, illustrations being given of complete installations, the whole forming a collection of operative data seldom found in any department of engineering work.

The subject of marine steam turbines is given a very full chapter, and the work concludes with a bibliography, including the principal articles in the technical press from 1888 down to, and including 1905. The book contains many useful tables, both in the British and metric systems, and is provided with a very full index.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXXI · AUGUST, 1906. No. 5.

THE GAS-TURBINE. SOME TESTS OF ITS PRACTICAL EFFICIENCY.

By Dr. C. E. Lucke.

The gas turbine is probably the most actively interesting problem in the field of dynamic engineering at the present time, and Dr. Lucke is one of the few workers in the subject whose investigations are pioneer—one of the fewer still who places his results freely and fully at the disposal of the profession. His article published in these pages in April, 1905, has become one of the classics of the literature of the subject, and has been recognized as basic by all later investigators. The paper now presented is yet more important and valuable, because it carries much farther and demonstrates much more concretely the fundamental proposition laid down in the preceding contribution.—THE EHITORS.

DURING the past few years the possibility of building a commercial gas turbine has interested inventors and engineers probably as much as the theoretical possibilities of this method of converting heat into work have engaged the attention of scientific men. At the present time, and as a result of these investigations, it has been shown that theoretically there is nothing whatever impossible in the problem, as is demonstrated in some two-dozen papers, most of them quite recent. In spite, however, of the conclusions that have been reached by the scientific men, that there is nothing impossible (that is to say, nothing scientifically impossible) in the conversion of heat energy into work by a gas turbine, the fact cannot be denied that there is not today any tangible result in the form of a working machine.

Inventors and engineers have experimented with a complete gas turbine, with and without steam, as well as with the various elements going to make up the system, such as the compressor, the fire, the nozzle and the turbine wheel. Some of these experimental combinations have been made to run, but they cannot be considered as working machines when they merely run. To receive any consideration whatever as useful machines, they must somewhere nearly approach the steam engine or the gas engine in economy, or show promise of so doing, and must, at the same time, approach the steam or the gas engine in reliability, life, space occupied, and other commercially valuable features.

It is to be regretted that by far the most of the experimental results along these lines have been suppressed. The inventors or experimenters apparently hoped to achieve something wonderful, something which must not be disclosed to the world too soon, and so they have concealed their early work. Later, when the machine was built and operated, the failure of the machine was so humiliating that in some cases the experimenter was ashamed to publish his his results, and in still other cases it appears that large sums of money were spent for the experiments, and those who spent it did not feel inclined to give the results to the world, because they had been obtained at such large individual expense. If the results of every man who had experimented with this problem had been published, there would have been less experimenting, because it is certain that the failures of one man would have saved another. It is also extremely probable that if the results had been systematically published and given freely to all who were interested in the problem, we would today be much nearer success, or more certain of its impossibility. If a problem can be shown theoretically to be possible of solution, and when practically it is sought to carry it out in a machine the effort is without success, it may be set down as a fact that either the theory was wrong, or being right, beyond dispute, all that is necessary for its ultimate success is time, energy, and money—assuming, of course, that the result is worth while and of commercial value when attained.

Another thing to be regretted in this gas-turbine situation is the fact that instead of experimenting, many of the writers on the subject have contented themselves with mere reiteration of the well-known scientific fact of theoretical possibility. In some of the discussions on the subject the arguments have become quite bitter, all because they have been based upon one man's opinion as opposed to another, and not upon an experimental fact, which could easily be verified by anyone having the requisite apparatus. In a paper published in this Magazine about a year ago, I pointed out one of the difficulties of executing a practical gas turbine—free expansion by means of the nozzle. That there were other difficulties everybody knew at the time, and these have been very much enlarged upon in more recent papers, but it seems to me that the most basic difficulty was the one previously made prominent. It was found by experimenting with nozzles that the temperature-drop in the nozzles between the place of no velocity and high pressure and the place of maximum velocity and low pressure was very small, and averaged about 12 per cent of what is theoretically possible, and of that which would be attained by a piston expansion of the same gases. Since that time, the temperature-drop in an actual turbine has been measured and compared with the theoretical pressure drop and the performance of the turbine operating with air has been measured. For convenience of operation the air was cold air, whereas in the practical gas turbine the air would be hot and possibly more or less mixed with steam, or possibly no air at all but carbon dioxide and nitrogen. In any event, the working fluid would be largely a perfect gas. The turbine used was a De Laval standard 30-horse-power machine intended for steam at 110-pounds pressure and having six nozzles. The turbine wheel runs at 20,000 revolutions per minute, and the power shaft 2,000 revolutions. The air used for driving the turbine was measured by a Westinghouse meter. The tests were run on no load, because the compressor used was not sufficiently large to supply the amount of air needed at full load, or even at full speed without load. With each type of nozzle three different initial pressures were used, each with a different number of nozzles. Readings were taken of the temperature of the air entering the turbine and the temperature of the air in the exhaust chamber, with the corresponding pressures. This turbine was fitted for six nozzles in all, grouped in three pairs of two each. These nozzles were all designed for 110-pounds initial pressure at three different back pressures—atmospheric, 25.5 inches vacuum and 26.3 inches vacuum. The groupings of the nozzles and the number designating their design characteristic are given in the following table.

Hole Number	Nozzle Number	Initial Pressure, Gauge	Vacuum, Inches of Mercury.
1	264	110	25.5
2	84	110	0
3	266	110	26.3
4	264	100	25.5
5	84	110	0
6	266	110	26.3

The results of the temperature-drop runs are given in the following table, which also gives the theoretical temperature-drop, assuming an adiabatic expansion of air between the same pressures.

INITIAL Press.	INITIAL Temp.	FINAL Press.	OBSERV. Temp.	FINAL Press	THEOR. Temp.	TEMPER Observ.	DROP Theor.	Per cent. of Theor. Realized	SPEED	EXPONENT Theor.	EXPONENT Observ.
85	98	.03	58	.03	−123	40	221	18.1	1,920	.290	.0380
55	93	.02	89	.02	−103	24	201	11.9	1,560	"	.0369
24	96	.01	83	.01	− 40	13	136	9.5	950	"	.0240
54	97	.10	81	.10	−102	18	201	8.9	1.880	"	.0198
40	102	.08	86	.08	− 76	17	178	9.5	1.630	"	.0232
24	109	.03	93	.03	− 30	16	139	11.5	1,200	"	.0262
35	108	.08	91	.08	− 61	17	169	10	1,695	"	.0252
23	104	.05	95	.05	− 30	9	134	6.7	1.290	"	.0156
12	101	.03	96	.03	− 1	5	100	5.	855	"	.0169
123	85	.01	60	.01	−176	25	261	9.6	1,540	"	.0206
92	91	.01	62	.01	−150	29	241	12.	1.270	"	.0258
60	91	.00	69	.00	−116	22	207	11.6	1,940	"	.0251
95	83	.01	51	.01	−157	26	240	10.8	1.750	"	.0240
76	93	.02	66	.02	−134	27	227	11.8	1 565	"	.0282
58	92	.02	68	.02	−113	24	205	11.7	1,285	"	.0289
75	81	.02	59	.02	−140	22	221	10.	1,710	"	.0226
54	89	.01	70	.01	−109	19	198	9.6	1,410	"	.0232
35	92	.01	74	.01	− 72	18	164	11.	1,075	"	.0268
68	88	.02	48	.02	−128	40	216	18.5	1,855	"	.0420
52	89	.01	59	.01	−106	30	195	15.4	1,660	"	.0374
32	87	.01	68	.01	− 69	19	156	12.2	1,220	"	.0380
42	86	.09	63	.09	− 90	23	176	13.	1,670	"	.0382
31	89	.07	78	.07	− 65	11	154	7.2	1,505	"	.0152
17	87	.03	82	.03	− 23	5	110	4.6	1,040	"	.0130
123	88	.14	68	.14	−173	20	261	7.7	1,140	"	.0160
91	93	.09	76	.09	−148	17	241	7.1	880	"	.0155
61	91	.05	80	.05	−120	11	211	5.2	530	"	.0122
103	91	.30	76	.30	−157	15	248	6.1	1,300	"	.0133
68	93	.22	81	.22	−124	12	217	5.5	910	"	.0117
48	90	.12	82	.12	− 98	8	188	4.3	520	"	.0105

Pressure in pounds gauge. Temperatures in degrees Fahrenheit.

RESULTS OF TEMPERATURE-DROP RUNS WITH DE LAVAL TURBINE, WORKING WITH COMPRESSED AIR.

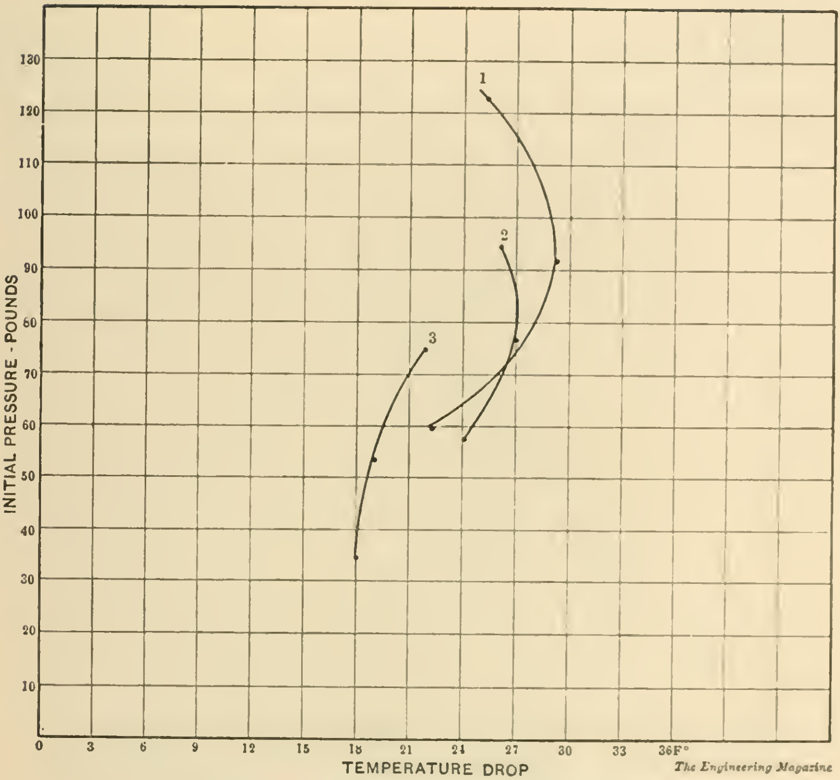

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DIAGRAM NO I. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 107 nozzles; 30 horse-power. 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

From this it appears that the temperature-drop realized varies from 4 to 18 per cent of the theoretical or adiabatic temperature-drop. The preceding results are given with respect to speeds also, which varied from 520 to 1,920 revolutions per minute. To show according to what law this complete process takes place, the exponent of the temperature ratio in the equation between pressure ratio and temperature ratio, which for adiabatic expansion of air is .29, was determined and found to lie between .1005 and .0380. When plotted with respect to initial pressure the temperature-drop seems to be erratic, as shown in Figure 1 for No. 107 nozzles, Figure 2 for No. 88 nozzles, Figure 3 for No. 84 nozzles, Figure 4 for No. 266 nozzles. For each of these the proper speed can be determined from the table preceding. In general, it appears that the temperature-drop is greatest for the greatest

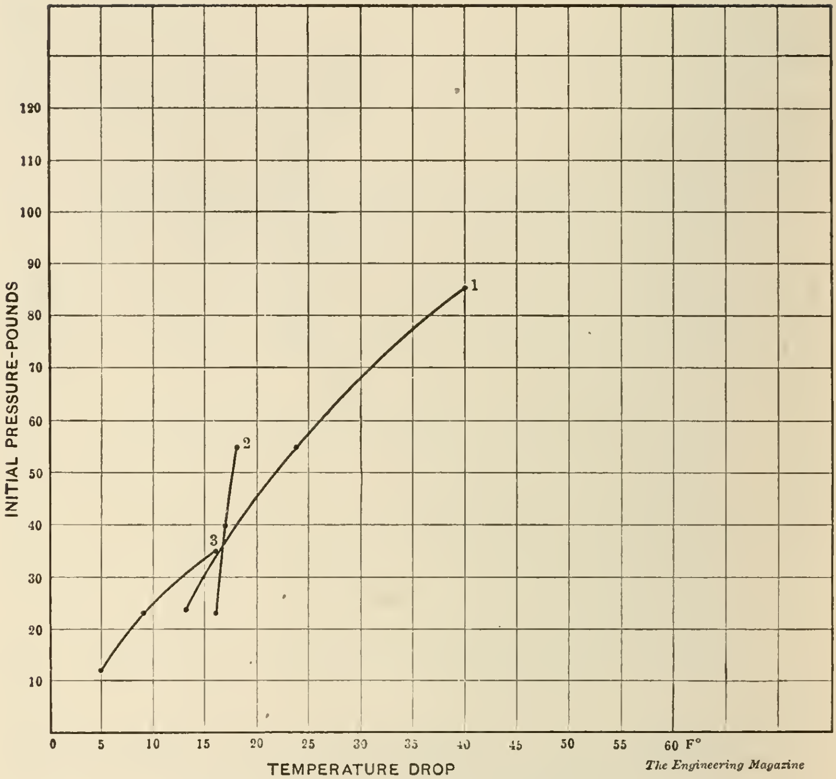

DIAGRAM NO. 2. TEMPERATURE-DROP OF AIR.

De Laval steam turbine, No. 84 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

initial pressure, but is not proportional to the nozzle pressure, and that in some cases the temperature-drop varies very little with changes in pressure, but is in all cases affected by the number of nozzles open. It also appears that speed has an influence, although a somewhat erratic one. In general, however, when the speed is greatest the temperature drop is greatest, which shows that there is a heating effect due to impact on the vanes, which is quite material and quite measurable. The nozzles differ in divergence and it appears that the results differ for different nozzles, showing that the temperature-drop is also, as might be expected, a function of the divergence of the nozzle.

Bearing somewhat on the above, but not directly, is the relation between initial pressure on the nozzles and the speed of the turbine running on no load, as was mentioned before. These relations are

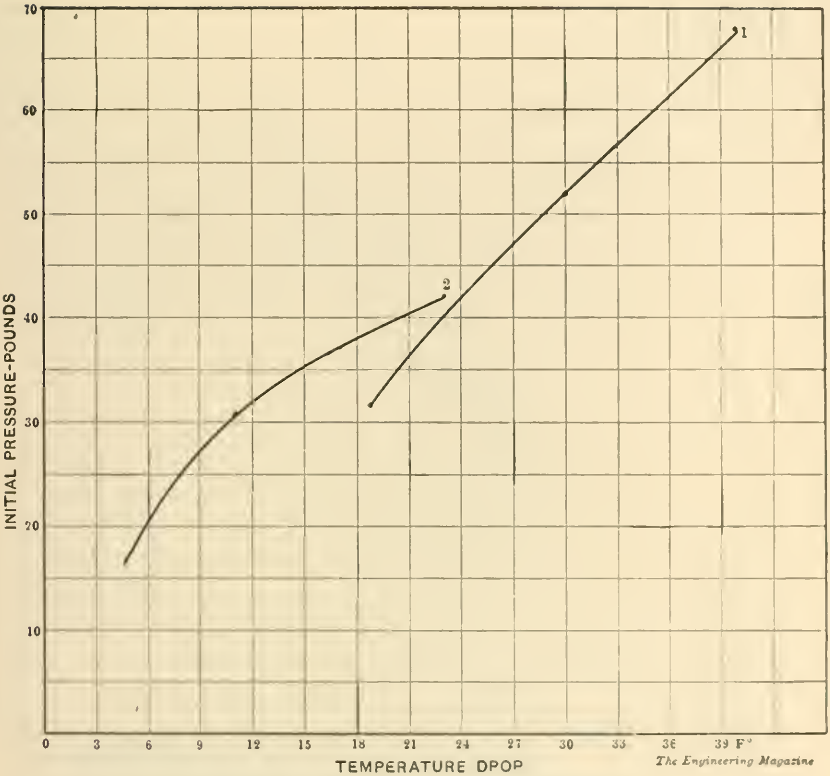

DIAGRAM NO. 3. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

given in the curves of Figures 5, 6, 7 and 8, from which it appears that speed is very nearly proportional to initial pressure but that for equal increments of initial pressure the speed increases in proportion. It also appears that the results are quite different for the different nozzles and with one nozzle and two nozzles open. The amount of air used by the turbine under these tests is plotted in curves of Figure 9 with respect to initial pressure and in Figure 10 with respect to speed. As a matter of general interest on turbines, the amount of power necessary to drive the wheel in an atmosphere of steam and air separately was measured by driving the turbine by a motor. The input energy was determined for the belt and bearing with the turbine wheel proper removed, and afterward with the turbine wheel revolving at various speeds in an atmosphere of air, then of steam. The

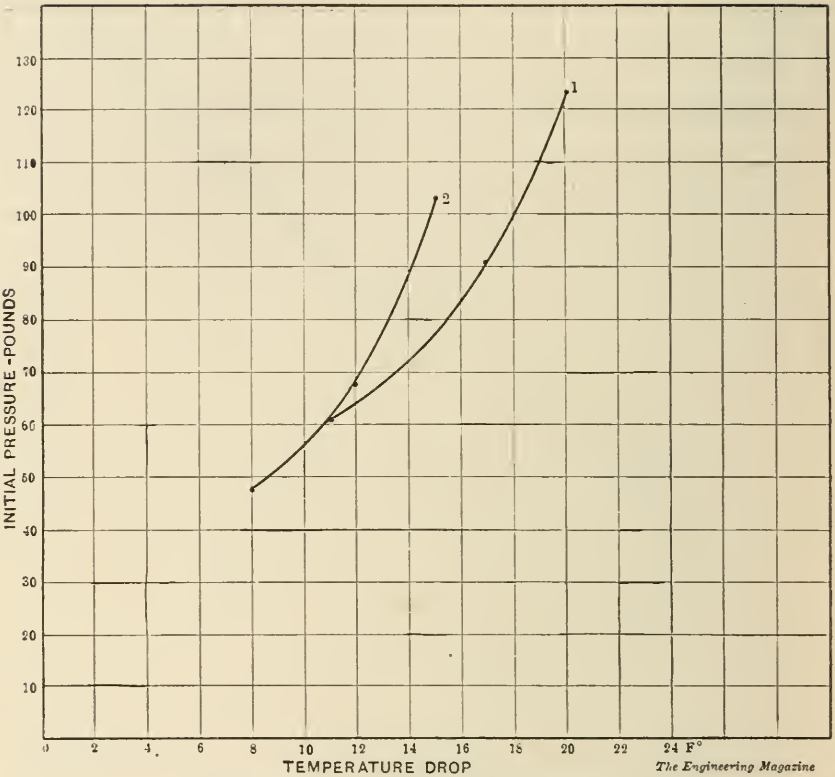

DIAGRAM NO. 4. TEMPERATURE-DROP OF AIR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

difference between these readings gave the horse power necessarily consumed by the turbine vanes beating the surrounding atmosphere. The results are given in the following table:

Turbine Speed R. P. M.	H. P. Loss, Atmos. Air	Turbine Speed R. P. M.	H. P. Loss, Steam
2140	11.55	2175	10.56
1550	5.56	1560	4.53
1080	2.48	1085	1.94
955	1.89	720	.87
644	.91	493	.56

By plotting these curves and comparing the horse-power loss with air and with steam at any given speed, it would be found that above 1,000 revolutions per minute, almost exactly, the windage loss by the vanes beating in air is 1¼ times the corresponding loss with the vanes beating in saturated steam at the same pressure.

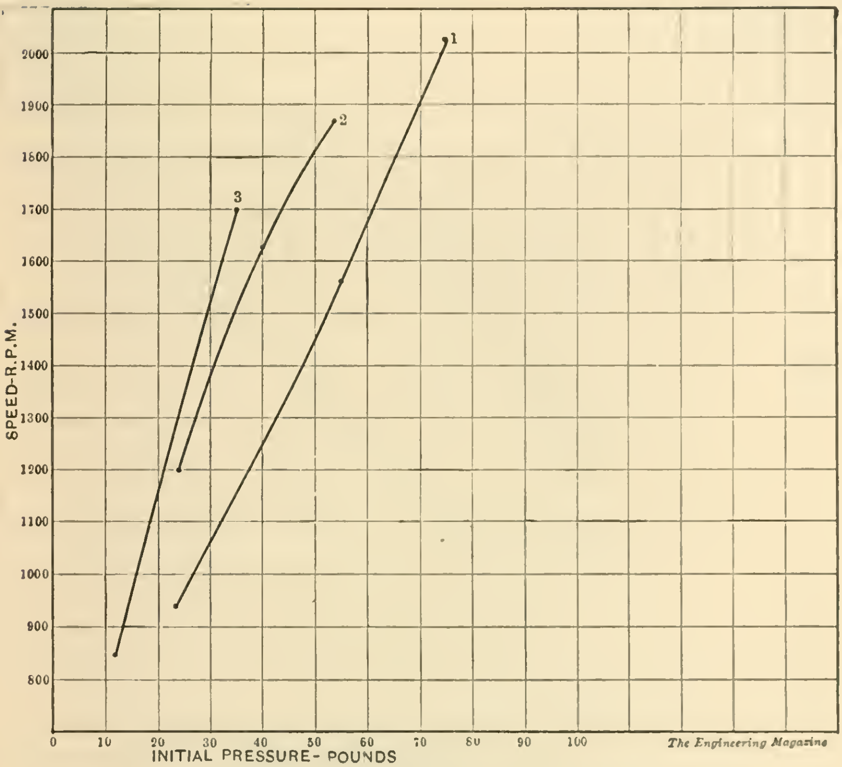

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DIAGRAM NO. 5. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 88 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3 —Three nozzles open.

These experiments most emphatically confirm those previously reported, and the conclusions which were drawn from them—that the temperature drop in free expansion with such nozzles as have been used indicates very small conversion of heat into work. Stated otherwise, free expansion in such nozzles as these is very inefficient as a means for transforming heat into work.

Investigation by the author among men who have worked with compressed air and with jets and nozzles, both here and abroad, has failed in every case to develop a single case where there occurs a substantial cooling of perfect gases by free expansion. One man is probably better fitted to express an opinion than any other, by reason of his life work—Dr. Ernst Körting, inventor for many years of jet apparatus of all sorts, and of gas engines and producers. After a life

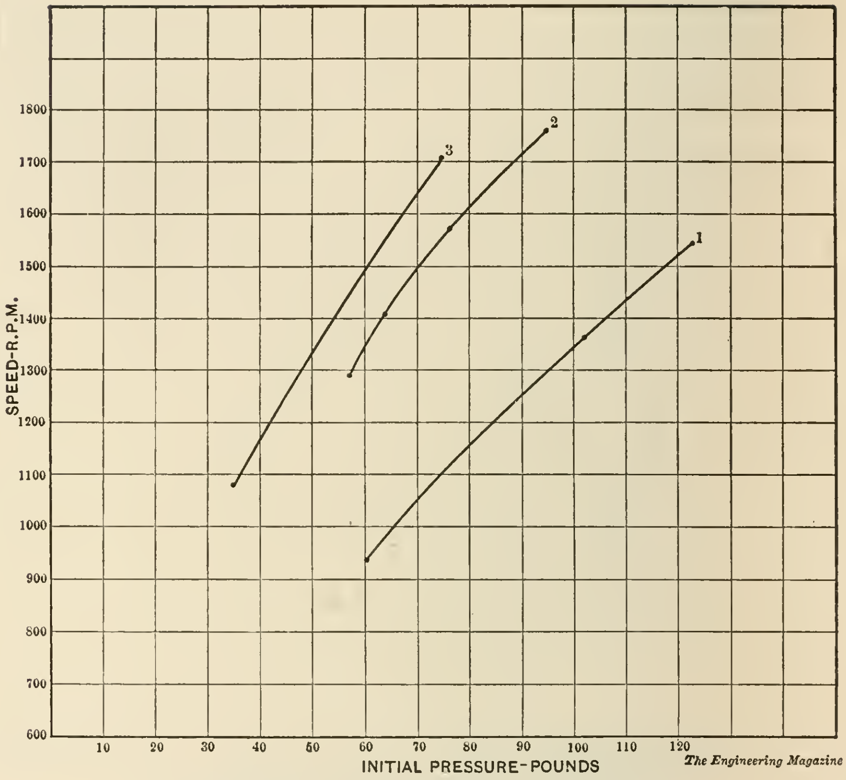


DIAGRAM NO 6. .SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 107 nozzles; 30 horse-power, 110 lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.
3.—Three nozzles open.

spent in jet and gas-engine research, which has been signally successful financially and scientifically, Dr. Körting sets it down as a fact that he has never noted a single case of efficient expansion of gases, as shown by temperature-drops.

In order to secure some idea of the attitude of other engineers towards this gas-engine situation, I addressed the following series of questions to a number of men whose opinions seem to be desirable:—

A. Do you consider that there is anything theoretically impossible in the production of a gas turbine, with or without the use of steam?

B. Do you consider that there is anything practically prohibitive in carrying out the necessary process to produce a gas turbine, using either perfect gas or a mixture of perfect gas and steam?

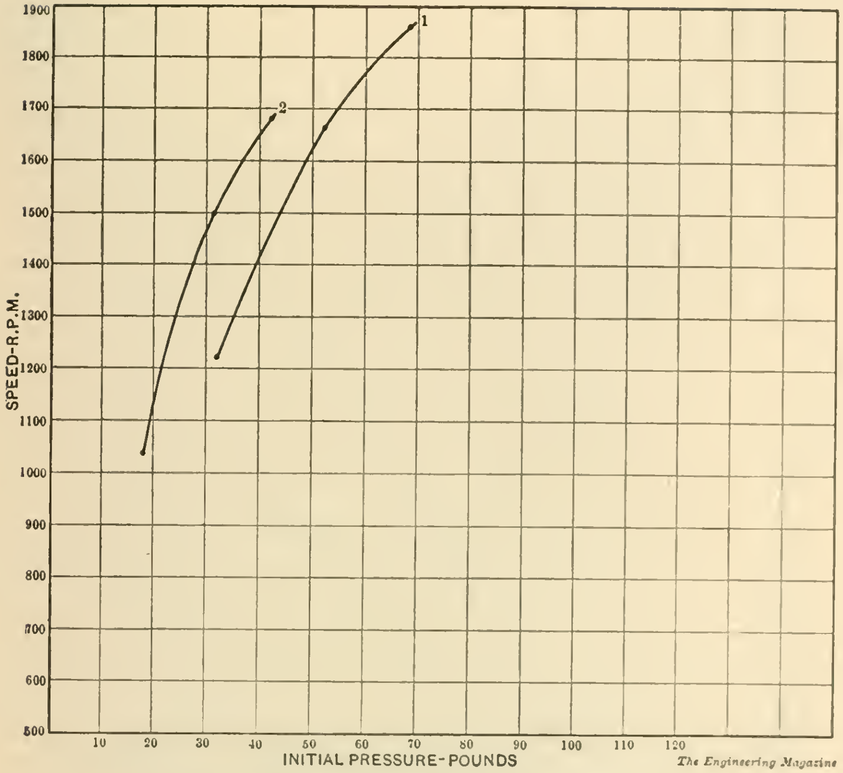


DIAGRAM NO. 7. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 84 nozzles, 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

C. What do you consider are the prospects of overcoming such difficulties as exist?

D. Do you consider that there is anything theoretically or practically difficult in the compressor part of the system?

E. In the combustion chamber of the system?

F. In the control of hot gases alone or with steam?

G. In the nozzle part of the system?

H. In the turbine-wheel part of the system?

I. In any other part of the system?

These men represent the steam-turbine field, gas-engine field, and scientific workers not identified with any particular field. Not quite half the people to whom the questions were sent replied at all, and curiously enough, most of the gas-engine engineers are in this class. Replies such as were received are given on the following pages:

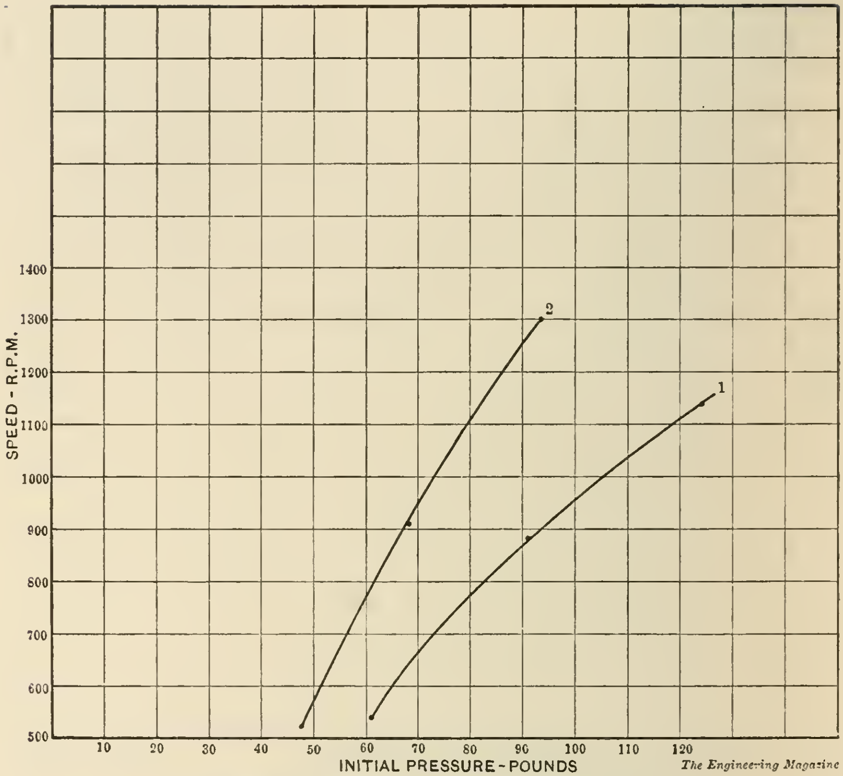


DIAGRAM NO. 8. SPEED-PRESSURE CURVES FOR AIR.

De Laval steam turbine; No. 266 nozzle, 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

Prof. R. C. Carpenter:

"Respecting the future commercial success of the gas turbine, I would state that I have formed an opinion which is unfavorable, due to the extremely high temperature which the working parts must be subjected to.

"Quite a number of experiments respecting the gas turbine have been carried on in our laboratory during the past eight or ten years. I felt at first that the machine could be made a practical success, but latterly I have concluded that the practical difficulties were nearly unsurmountable.

"In my opinion there is nothing in fault with the theory of a gas turbine without the use of steam, but I do not believe that there is any immediate prospect of securing metals which will stand the high temperature required for the nozzles and buckets.

"Respecting the use of a combined gas and steam turbine, I have at the present time no definite or positive information which will enable me to express an opinion as to its future practicability. I think, however, that a turbine working on such a combination might have a fighting chance of succeeding."

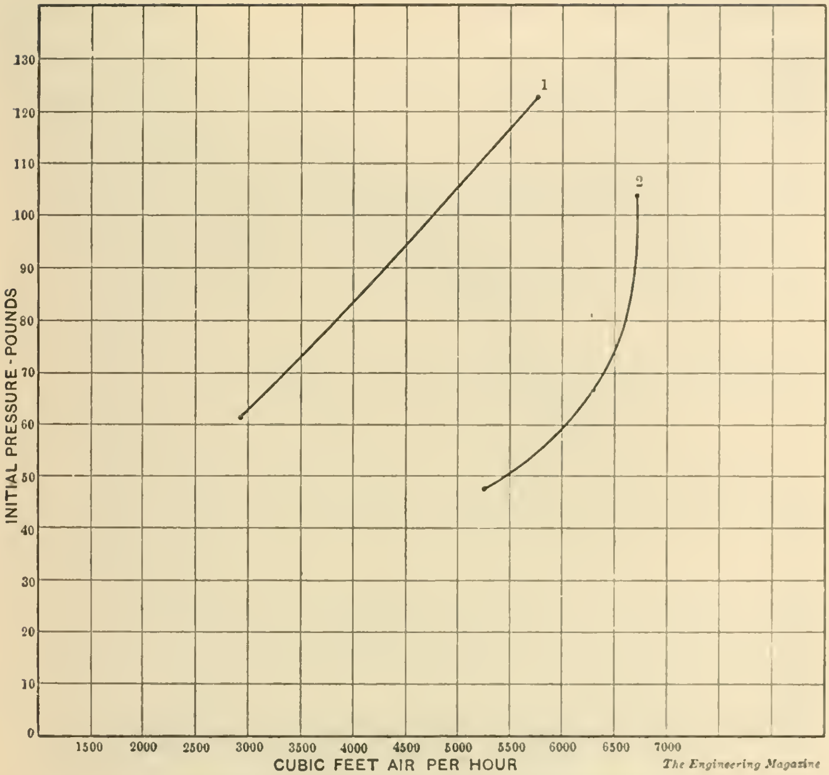


DIAGRAM NO. 9. CUBIC FEET OF AIR PER HOUR.

De Laval steam turbine; No. 266 nozzles; 30 horse-power, 110-lb. pressure, 2,000 revolutions per minute.

1.—One nozzle open.
2.—Two nozzles open.

Prof. Sidney A. Reeve:

"A. No.

"B. At present, Yes.

"C. The prospects are excellent. The gas turbine is a new problem. The devices already standard in engineering practice were developed to meet earlier conditions. The conditions of the new problem are different. The usual period for the experimental development of a solution of the problem of building old devices along new lines is all that intervenes between the present and a practicable gas turbine.

"D. Theoretically, No. Practically, Yes. The compressor is the only unsolved and difficult part of the problem.

"E. No, either theoretically or practically.

"F. With permanent gases, yes. With steam, no.

"H. No.

"I. No.

"G. No."

Prof. Wm. T. Magruder:

"A. I see nothing theoretically impossible in gas turbines, although I am not prepared to predict how economical they will be in the use of fuel and repairs in practice.

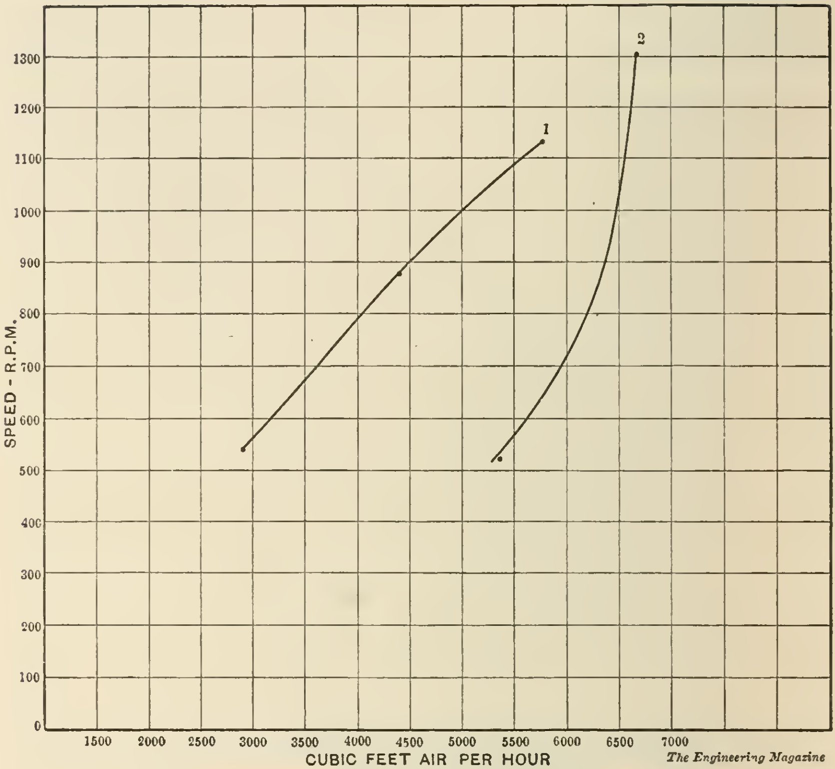


DIAGRAM NO. 10. CUBIC FEET OF AIR PER HOUR.

De Laval steam turbine: No. 266 nozzles, 30 horse-power, 110-lb. pressure, 2,000 revolutions.
1.—One nozzle open.
2.—Two nozzles open.

"B. I feel that the obtainable temperatures which are desired for maximum efficiency may cause great difficulty, unless a suitable porcelain can be obtained.

"C. I have faith enough to believe that the difficulties will be overcome.

"D. I am not prepared to say that the compression is absolutely necessary, and believe that the difficulties peculiar to the problem can be overcome. A motor-driven, 550-revolution, 3,000 pounds pressure, four-stage air compressor at 85 per cent pneumatic efficiency is the latest success in this line.

"E. Your work is an answer to this question.

"F. Without steam, it is the most serious proposition.

"G. Cannot say. Would try porcelain.

"I believe that a solution of the problem will be effected which, in its way, will be as novel as that of the steam turbine. I would, however, prefer not to make any predictions or statements at present."

Mr. J. F. Aue:

"Replying to your letter, would say that I have not paid much attention to the problem of gas turbines because I have no faith in their practical and commercial success.

"I consider myself, therefore, not competent to answer the questions."

Mr. F. E. Junge:

"A. No.

"B. No.

"C. Prospects are good if efficiency of proposed turbine is second consideration.

"D. Nothing.

"E. Yes, difficulty of cooling.

"F. Yes, thermal inefficiency when steam is generated by injecting water into combustion chamber before or during combustion.

"G. No, if properly designed.

"H. Yes, impossibility of cooling blades and finding proper material to stand high temperatures continuously.

"I. None but lack of interest in manufacturing circles and among investors."

Mr. Arthur West:

"I beg to acknowledge your letter relating to the gas turbine situation, and in reply regret to say that I have not given the subject sufficient consideration to intelligently answer your questions."

Francis Hodgkinson:

"I beg to acknowledge receipt of your letter regarding the gas-turbine situation and in reply regret to state that I can add nothing to the subject of this art. As my time has been fully occupied with steam turbines, I have not studied the subject of gas turbines."

Prof. Elihu Thomson:

"The problem of the gas turbine is certainly a very complex one, and I do not know that I am prepared to answer the questions you put, definitely, at this time. Such data as we have collected from our experimental work are naturally to be regarded as private with the General Electric Company, and, therefore, not to be used in publication. Perhaps it would be sufficient to make a general statement which covers most of the points of your questions. In the first place, I see no theoretical impossibility in the gas turbine with or without the use of steam, but I consider that the practical problems are of great difficulty, and especially the problem of compression. If we are to depend upon reciprocating compressors the question arises at once whether we had not better make them into gas engines. There certainly need be no difficulty in managing the combustion part of the process if oil or gas fuel is available. I regard the problems of construction and operation as certainly difficult, and considerable time will probably elapse before any thoroughly workable gas turbine is produced, and the problem of its competing with other machines is naturally somewhat doubtful."

W. L. R. Emmet:

"I have received your letter concerning gas turbines. About four years ago I became interested in this subject, and for a time believed that something valuable might be developed. I began to build some experimental apparatus, but gave up the work before any actual experimenting had begun. My reason for giving it up was that certain theoretical and practical considerations seem to indicate that the prospects were not attractive. My study of the subject was not very thorough, and I will not undertake therefore to express an opinion. I will, however, state briefly some of the considerations which influenced my decision.

"The useful product of a gas turbine with combustion chamber is the difference between the output and the power required for compression. Inefficiency in the process of compression or of conversion into work rapidly diminishes the useful product. The theoretical velocities are high,

> and consequently the turbine element is difficult to make efficient. The cost of efficient air-compression apparatus is very great, and the result produced is not very good. I do not know what actual combined efficiency of combustion chamber and nozzle would be practicable, but I am inclined to think that a good deal of loss will be found in these parts. If high temperatures were used, combustion will probably be delayed until after expansion, which will involve large losses and practical difficulty. If low temperatures are used through the introduction of water, the process rapidly degenerates into a non-condensing superheated-steam process, which is hampered by the necessity of compressing all the air used for combustion.
>
> "Under the most favorable conditions which can be assumed, the heat rejected in exhaust must be very large, and cannot be economically returned to the system itself, since it is expensive to compress hot air. This rejected heat could, of course, be used in a steam process, but there are obvious objections to such complicated combinations.
>
> "Even when due allowance is made for these difficulties, theory would indicate that fair ecenomy might be obtained from a gas turbine. The development of any practicable process of this kind involves a great amount of thought and labor, and all that I can say of this process is that it seems to afford a less attractive field for development than many others to which a competent engineer might devote his energies."

After a review of the whole situation, it appears that theoretically there is nothing impossible in the problem, and such difficulties as exist are purely practical and of no mean order of magnitude. So great are the difficulties encountered by those who have experimented, and so great are those that are foreseen by practical men, whose lives are devoted to overcoming difficulties, that those who are engaged in trying to perfect such a machine as this are warned of the certainty that their efforts will be fruitless for a long time at least, that much money will be spent with no tangible results, and that the practical gas turbine is a long way off.

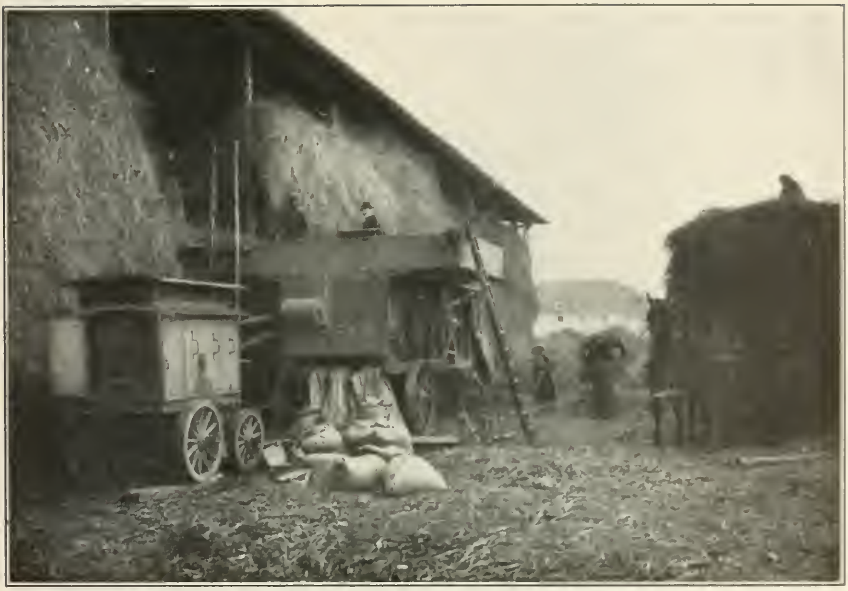


FIG. I. THRESHING MACHINE DRIVEN BY A PORTABLE ELECTRIC MOTOR

THE APPLICATION OF ELECTRIC MOTORS TO AGRICULTURAL OPERATIONS.

By Franz Koester.

Mr. Koester's topic is of interest to THE ENGINEERING MAGAZINE, of course, by the significance it may have for the electrical engineer and manufacturer—not merely for the agriculturist. It is from this point of view that the author discusses a movement in which Continental initiative and precedent may suggest something to British and American industry.—THE EDITORS.

FOR a number of years, endeavor has been made to substitute mechanical means for the use of animal power in agriculture. The sources of power at first employed were windmills, water-wheels, etc. With this practice, the operation of farming implements and machinery was very materially complicated on account of the unavoidable introduction of long shafts, belts, pulleys, and other machinery of transmission, and in addition to this a still greater disadvantage lay in the fact that such power could be profitably utilized over a very restricted territory only, usually at the same point where the prime mover was installed. It was therefore practically impossible

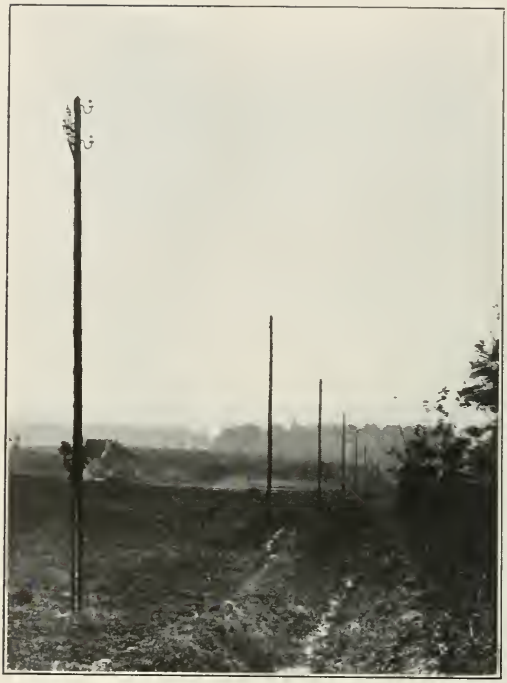
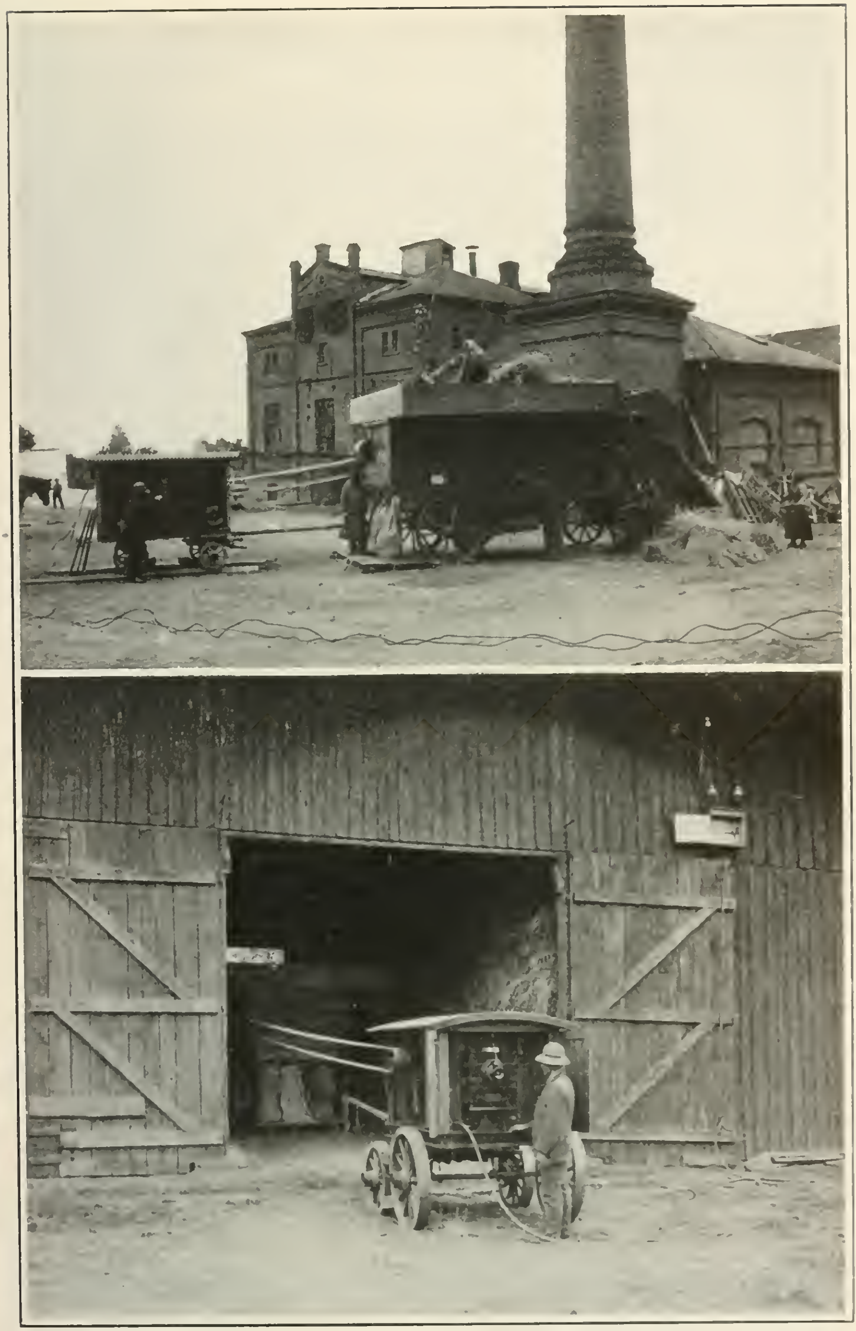


FIG. 2. OVERHEAD DISTRIBUTING SYSTEM. LIGHTNING ARRESTERS ON THE NEAREST POLE.

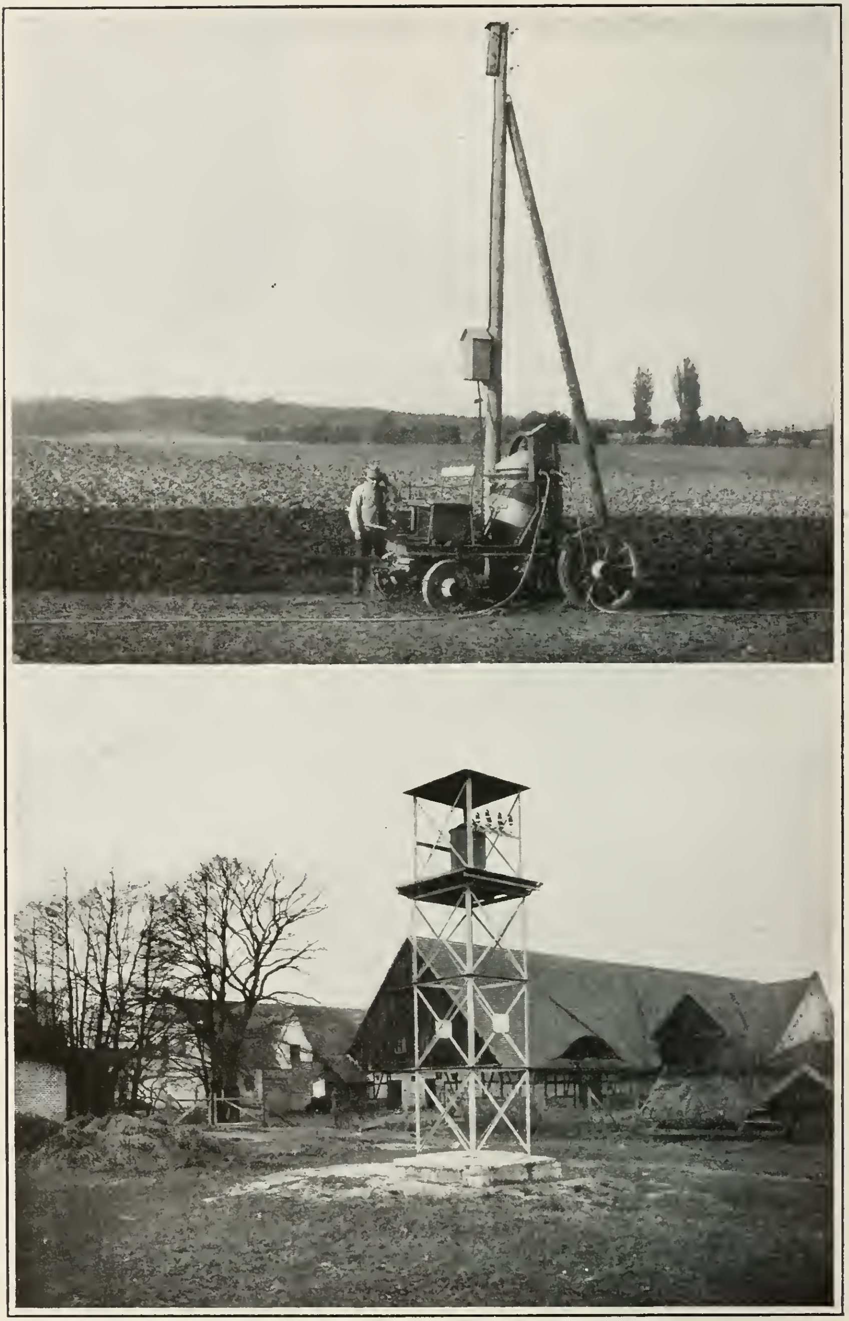
to utilize mechanical energy in the field for plowing, sowing, reaping, etc., as these require too flexible a system of distribution. On account of this latter requirement, the only mode of power easily available for this character of work is electricity. Nevertheless, before this decision had been reached portable steam engines had been used for plowing, thrashing, and other processes, but with less satisfactory economy, because water and fuel sometimes had to be supplied at great distances out in the field. Another serious disadvantage was due to the extremely heavy weight of the machinery, making it very difficult to transport it over hilly country and soft land—conditions in some cases being so severe, in fact, that it was found absolutely impossible to get the apparatus to the place of work.

On the other hand, the many advantages accruing from the use of electric power are apparent at once, as on account of the flexibility of the system, current may be easily distributed over large tracts of land, and feeders strung over the entire farm. The energy at any point may readily be converted into light, heat, or power, it being easy to transport a light electric motor over any ground. Another advantage of this system is that all the power may be drawn from a central point, as, for example, a private plant on the place; or where this is unavailable, it may be drawn at high potential from the nearest town or public-service central station and stepped down at transformer substations. If the farm is of considerable size and the consumption of energy great, or if its location is very far from any already developed outside source of supply, it will probably pay to install a private power plant. In such case a water power would be of great service, but



FIGS. 3 & 4. THRESHING BY ELECTRIC POWER.

In the lower example, the threshing machine is working directly within the barn itself, the motor being stationed outside.



FIGS. 5 & 6. STATIONARY AND PORTABLE TRANSFORMER STATIONS.

in the upper view, the attendant is shown using the field telephone where this natural source is not obtainable, a steam, gas, or oil-engine power plant may easily be installed, the exact type depending of course upon the local conditions in regard to the cost of fuel, etc. Where the size of the farm does not justify the installation of a private plant or even the purchase of an electric motor, it might prove profitable for the central station to organize a department for the renting of semi-portable motors, to be used for the above purposes. If this is not done, one farmer might buy a motor and when not using it himself rent it to his neighbors; or where no central supply of current is available, one farmer might install a private plant and sell power to his neighbors.

Power on the farm is not used only in the field, but is also applicable for use in the buildings (residence as well as work) where it may be used for light, motive power, and heat, when a storage battery might profitably be used.

For several years the application of electricity to agriculture has been continually growing on the continent of Europe, especially in Germany, where the proprietors of large farms have been brought to see the advantages of this system. Some of the largest electrical manufacturing firms of Germany have entered actively and profitably into the development and supply of machinery in the new field, and the accompanying illustrations show views, taken on some of the busy days, on farms where electricity is used exclusively for motive power. Figure 1, for instance, represents a thrashing machine, in front of which is a portable electric motor, the power being supplied from a distance by an overhead line, a typical illustration of which is shown in Figure 2. It will be noticed that this pole line carries not only the power feeds, but also telephone wires. As these lines are run exposed to all sorts of atmospheric conditions, of course they must be supplied with some sort of lightning arrester. In this particular illustration the well-known Siemens horn lightning arresters are shown on the first pole. Another portable motor is seen in Figures 3 and 4. While in some cases the grain is thrashed directly in the field, in Figure 3 it will be seen being thrashed in the farmyard and in Figure 4 in the barn itself. This latter illustration shows clearly the method of feeding the motor and also the requisite controlling devices. These motors (depending of course upon the size and capacity of the machine) vary from 5 to 15 horse power. Where high tension is used for distribution on account of the extensiveness of the fields, or when power is drawn from a central station, transformer stations are of course necessary. These are either stationary, as illustrated in Figure 5, where the

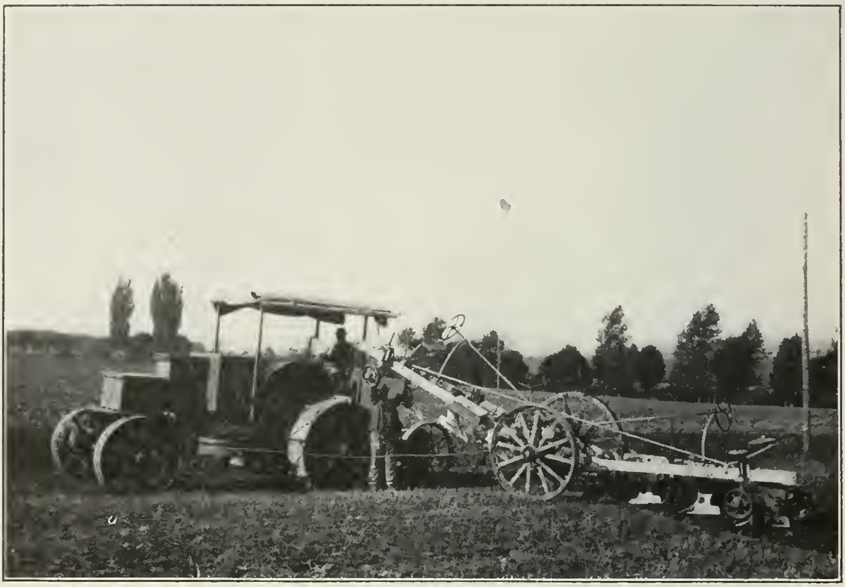


FIG. 7. A SIEMENS-SCHUCKERT REVERSIBLE PLOW, AND ONE OF THE MOTOR WAGONS OPERATING IT.

transformer is installed on a steel tower erected in the farmyard, or of the portable type shown in Figure 6, where a transformer mounted on a truck is carted from field to field as the service requires. It will be noticed that a flexible cable connects the high-tension overhead line with the transformer; thence the secondaries supply two local feeds

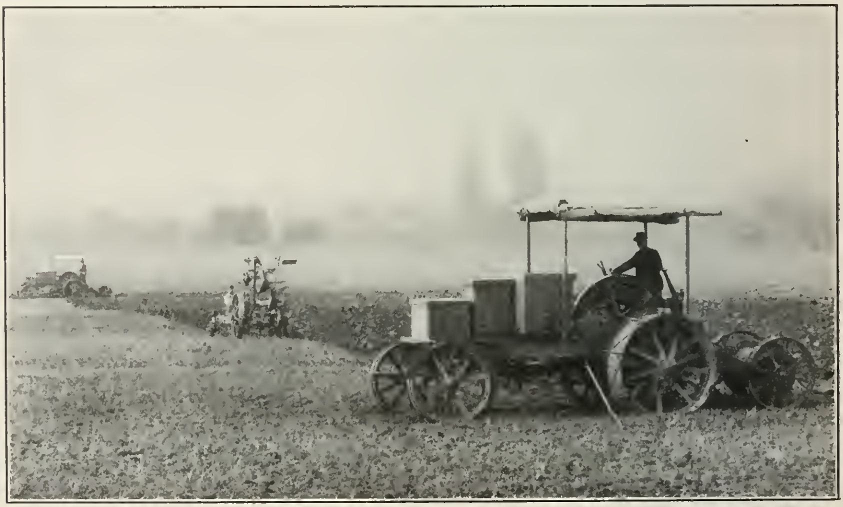


FIG. 8. COMPLETE EQUIPMENT OF A SIEMENS-SCHUCKERT TWIN OR TWO-MACHINE PLOW SYSTEM.

on the ground. In large fields these transformer stations are equipped with a telephone, which is clearly shown in the illustration.

Probably a somewhat more interesting illustration is shown in Figure 7, representing a reversible plow and a portable electric motor. Figure 8 shows more clearly the operation of this system, the plow being alternately drawn by similar machines at opposite ends of the field. These two motors are supplied by the two low-tension feeds shown on the ground in Figure 6. The power required by one of these twin machine plows depends of course upon the depth of the furrows, the quality of the soil, the number of shares, and the speed. The horse power usually required varies from 30 to 50. The first expense of such a plow system is comparatively high, the total cost of an equipment similar to that described being, according to the power, from 35,000 to 50,000 marks ($8,750 to $12,500); there is, however, no doubt but that if proper judgment is employed in selecting the exact size and type of machine, the money is well invested.

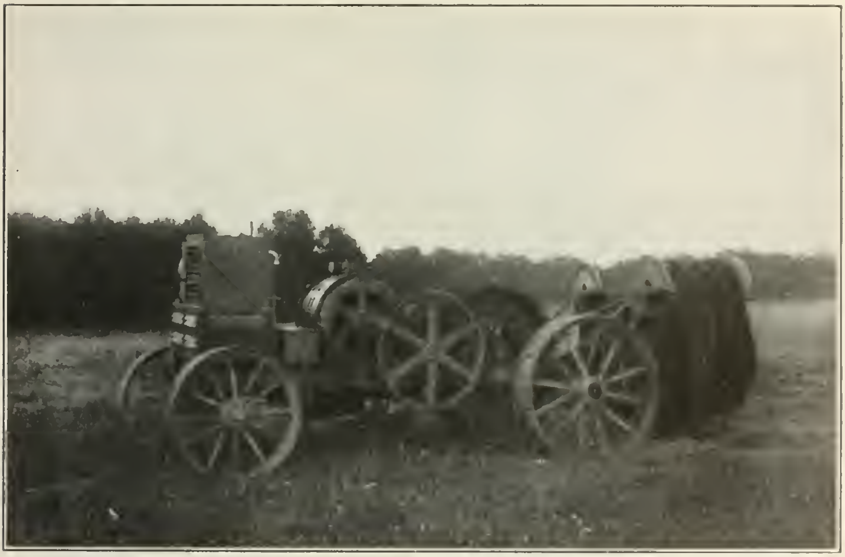


FIG. 9. MOTOR WAGON OF A SINGLE MACHINE-PLOW SYSTEM

The advantage of the twin-machine system over the single-machine system is that with the latter type it is necessary to anchor one drum every time the plow is drawn across the field. This process is simplified slightly by using an anchor wagon. This anchor wagon is provided with heavy flanged wheels similar to those shown on the motor wagon illustrated in Figures 7 and 8, and a sheave over which the cable, which pulls the plow, is run. When the plow is running toward the anchor wagon the latter is firmly held in its position by an anchor in the ground. When the direction of the plow is reversed, the tension on the anchor wagon is released and it is a simple matter for an attendant to lift a pin, removing the anchor from the ground, and by turning a windlass to advance the wagon to the position required for the return of the plow in the proper furrow. Figure 9 represents a motor-wagon equipment for a single-machine system. Unfortunately I am not in a position to furnish an illustration of the anchor wagon.

The method of drawing current from the overhead line for the plowing system is shown in Figure 10. The lines are connected to copper strips on the side of the pole supported on porcelain insulators. From these strips, which are located some distance from the ground, the connection is made to the motor, by wires running to the ground through stiff wooden conduits, and thence to the motor through an insulated flexible conductor. This sub-feeder is easily removable from one pole to another, although this is not necessary so very often as the plow generally carries a feeding cable from 1,500 to 3,000 feet long and in some cases even longer.

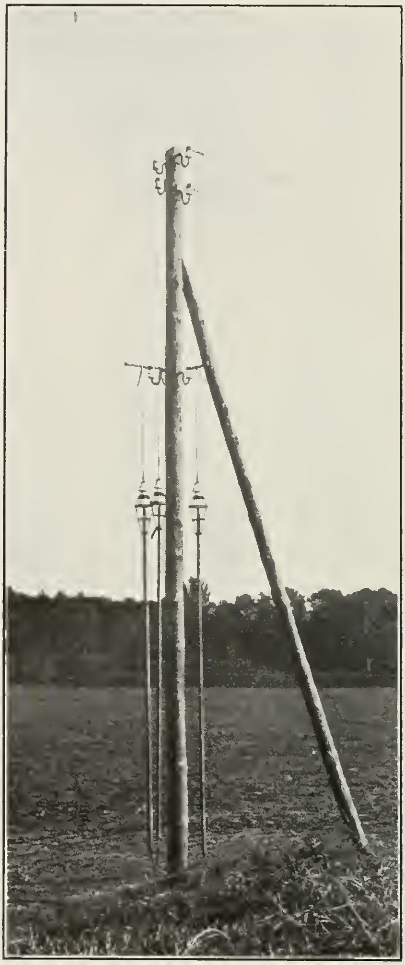


FIG. 10. CURRENT-COLLECTING DEVICE.

Note the copper strips at the base of the pole.

Another system also used (to a smaller extent) on the Continent is that in which the driving motor is mounted directly upon a reversible plow. Current is supplied through two side trolley wires.

Electricity is used not only in the open field, but also very extensively for operating the various kinds of dairy apparatus, for shearing

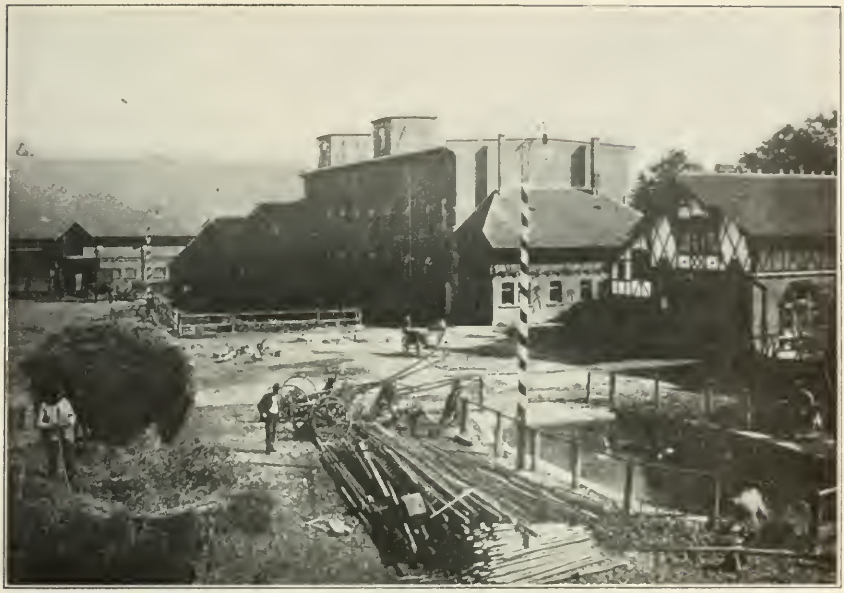


FIG. 11. GENERAL ILLUMINATING (ARC-LAMP) SYSTEM FOR THE FARMYARD.

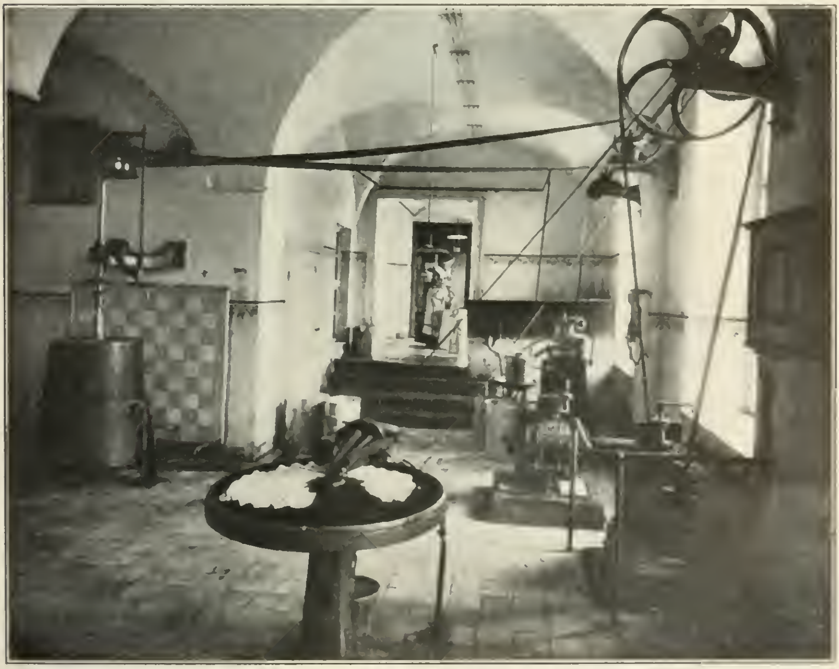


FIG. 12. A MOTOR INSTALLATION DRIVING VARIOUS UNITS OF DAIRY MACHINERY

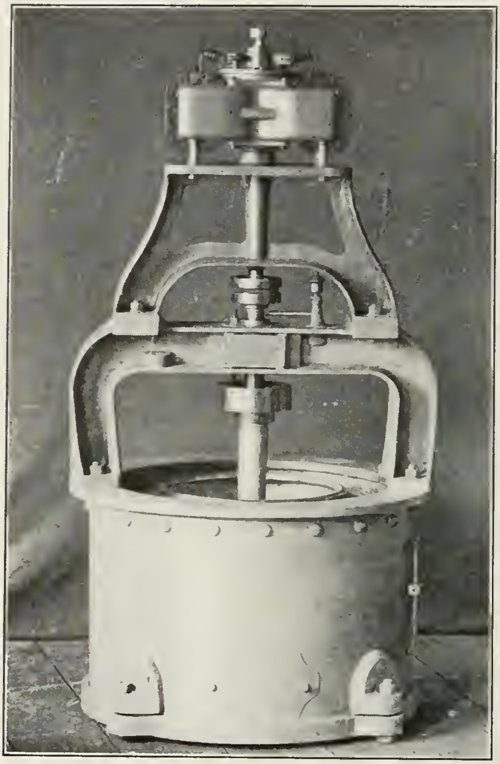


FIG. 13. AN INDIVIDUAL ELECTRIC-MOTOR DRIVE.

sheep, clipping horses, heating and ventilating, chopping food and wood, operating various pumps, sewing machines, cooking, etc.

Figure 11 gives an illustration of the general illumination of the barn yards of a prominent farm, by means of arc lamps. Frequently incandescent clusters are used for this purpose, while the various buildings are lighted almost exclusively by incandescent lamps, except when they are of very great size, where arcs are used to better advantage. Lighting is one of the most important uses to which electricity is put in the various farm buildings, as of course many places in them are very poorly lighted by natural illumination, especially in the early morning and late evening, at certain times of the year. Another important item in favor of the use of electricity for this purpose is the fact that the fire underwriters have made the premium rates lower where electricity is used than where petroleum or gas is employed, as was formerly the custom

In many cases where the size of the farm and the demand for power do not justify the installation of a large plant, a small generator direct connected to a benzine or gasoline engine of from 3 to 5 horsepower capacity is installed. This occupies a very small space, and its operation is most simple. Usually with this system a storage battery is installed, which is charged by running the generator at a convenient hour of the day, the battery discharging when required. With this equipment, practically any farm employee, with the proper instruction, may attend to the operation, while after working hours, with the battery only in operation, no attendance is required. As the potential chosen for these plants is usually 25 volts, the current is frequently

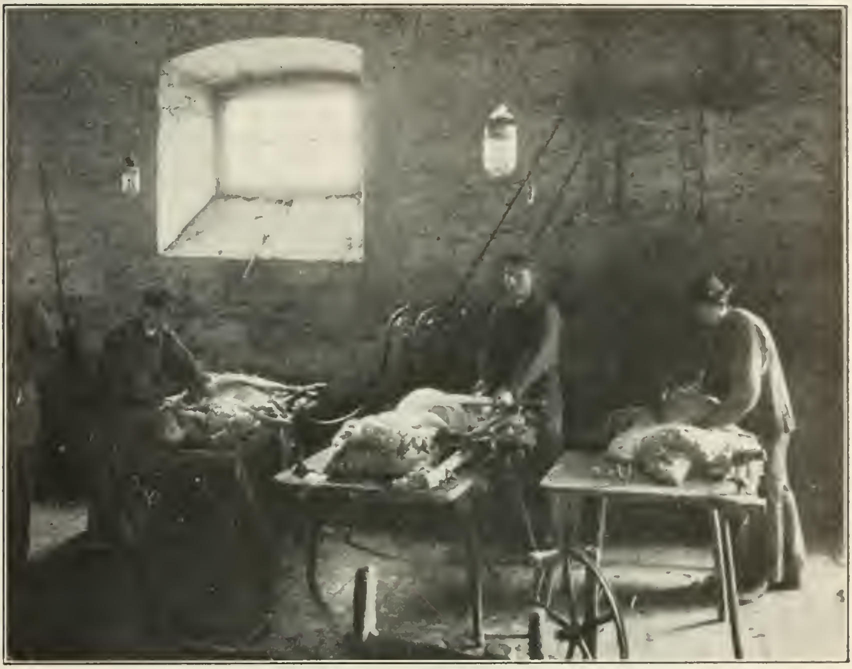


FIG. 14. SHEEP SHEARING BY ELECTRIC POWER

used for heating, cooking, ironing, operating sewing machines, etc.

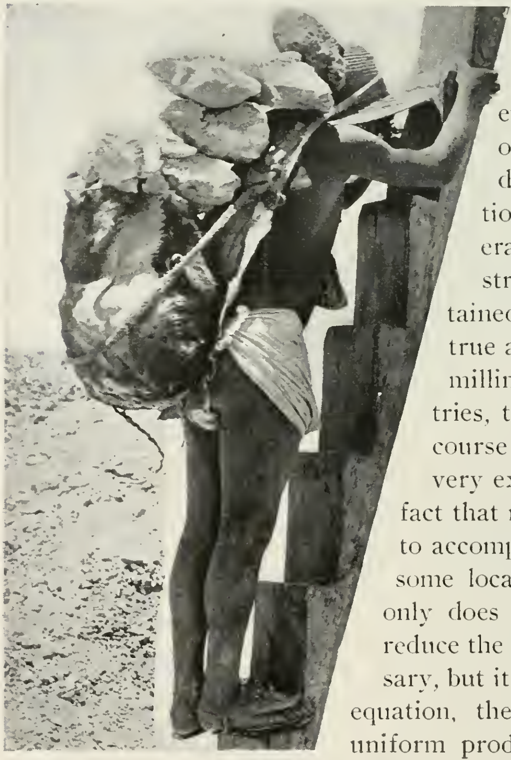
Frequently where one motor is used for the operation of several pieces of dairy apparatus a line shaft is employed as shown in Figure 12, when the motor is mounted on the floor. Where this is obviously disadvantageous, direct-connected motor drive is used, an example of which is shown in Figure 13, illustrating a centrifugal cream separator.

The possibilities of utilizing electric power on the farm in sheep shearing are very forcibly illustrated in Figure 14, while many other uses, agricultural, domestic, and culinary, may be found when the current has once been introduced.

MINING AND MILLING BY ELECTRIC POWER MACHINERY.

By Charles V. Allen.

Mr. Allen's article, reviewing broadly the field of electrical applications to mining, will be followed next month by a specific example in the case of one of the largest and most modern Mexican installations—modern, that is, in so far as concerns the electrical driving of all the machinery of the mine and mill.—THE EDITORS.

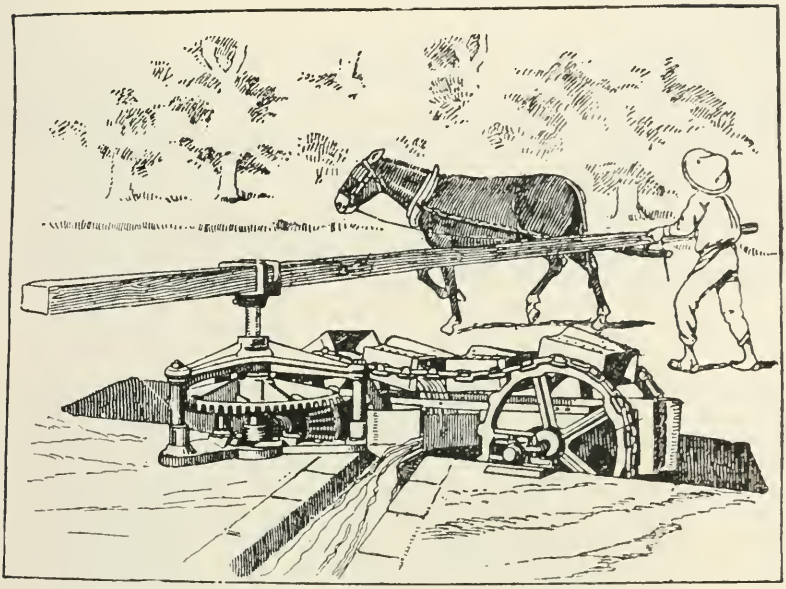


By courtesy of The Denver Engineering Works.

THE OLD WAY OF HOISTING IN MEXICO

The "pigeon ladder," still used to some extent.

THE fact that the application of electricity to nearly every form of industry not only increases the output but decreases the cost of production, has long since been generally accepted and demonstrated by actual results obtained. This is none the less true as applied to the mining and milling of minerals in all countries, though the saving would of course be greater where labor is very expensive were it not for the fact that more laborers are necessary to accomplish the same operations in some localities than in others. Not only does modern machinery greatly reduce the number of employees necessary, but it also eliminates the personal equation, thereby resulting in a more uniform product and stable output. A very good example of this is found in a Mexican mine, which recently installed some electric mining locomotives, each of which with fourteen men replaced forty-five men, at the same time largely increasing the tonnage output of the mine. In one case adopting electrical haulage has enabled a mine to double its output and reduce the cost of



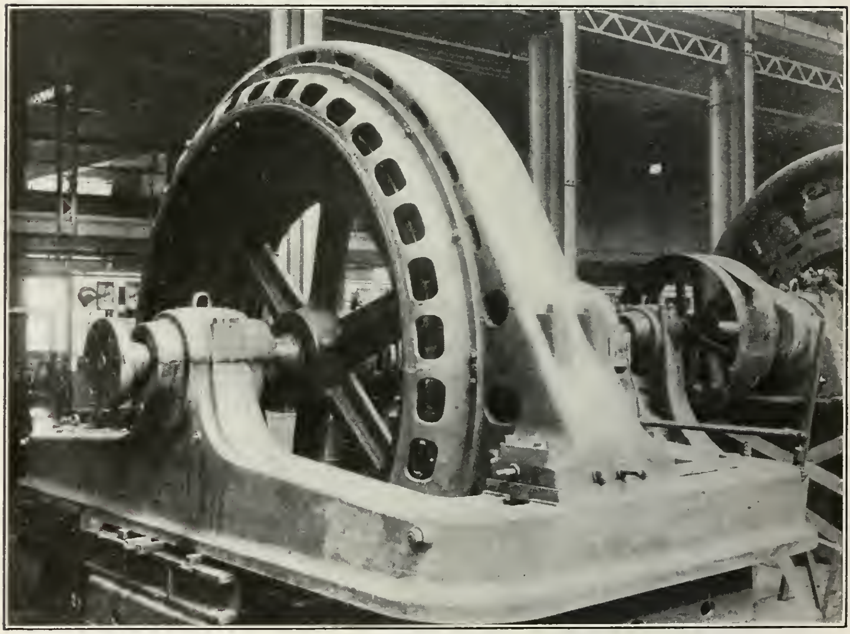
FORMER METHOD OF UNWATERING A MINE. DECIDEDLY LIMITED AS TO HEAD.

haulage from 8 cents to 1 cent per ton; this amounted to 30 per cent per annum of the sum invested in the electric power plant.

The unwatering of workings is one of the principal problems met with in mining. We know that over a hundred years ago, and up to quite recently, the natives in Mexico carried the water out on the backs of boys, and later hoisted it in a crude manner in hide bags or *mantos* with horse whims or *malacates.* We should expect economy over this method to follow the introduction of a modern high-speed electric centrifugal pump.

Before the electric pump, however, came the present steam pump which in service has proven very reliable. This, though still largely in use where electricity is not available, is now rapidly passing out of use where fuel is becoming expensive. An instance of the saving experienced in substituting electric-motor-driven pumps for steam-driven is afforded by a mine where the generating plant, motors, etc., cost $18,000, and secured a resultant annual saving of $6,000, after allowing for interest on investment and depreciation of the plant.

In the application of electricity to mining the economies do not all appear in the mere comparison of electric haulage with steam, compressed-air, or mule traction, and of electric pumps or hoists with steam or compressed-air pumps and hoists. The general flexibility and applicability of the electric system makes possible the centralization of the power-generating plant, the improvement of the mine conditions, the decrease in the number of men required to operate boilers, engines, pumps, etc., and the reduction in cost of oil and repairs. It also renders possible the installation of hoists, pumps, blowers, etc., at points prohibitive with steam on account of distance from the boiler plant, further resulting in a saving of space, a substitution of wires for pipes on the surface and in the mine as well, and providing a safe, economical, and efficient light for mine and mill. The increase in output and the more efficient service secured in a mine and cyanide plant well lighted with incandescent and arc lamps, is conceded by all.

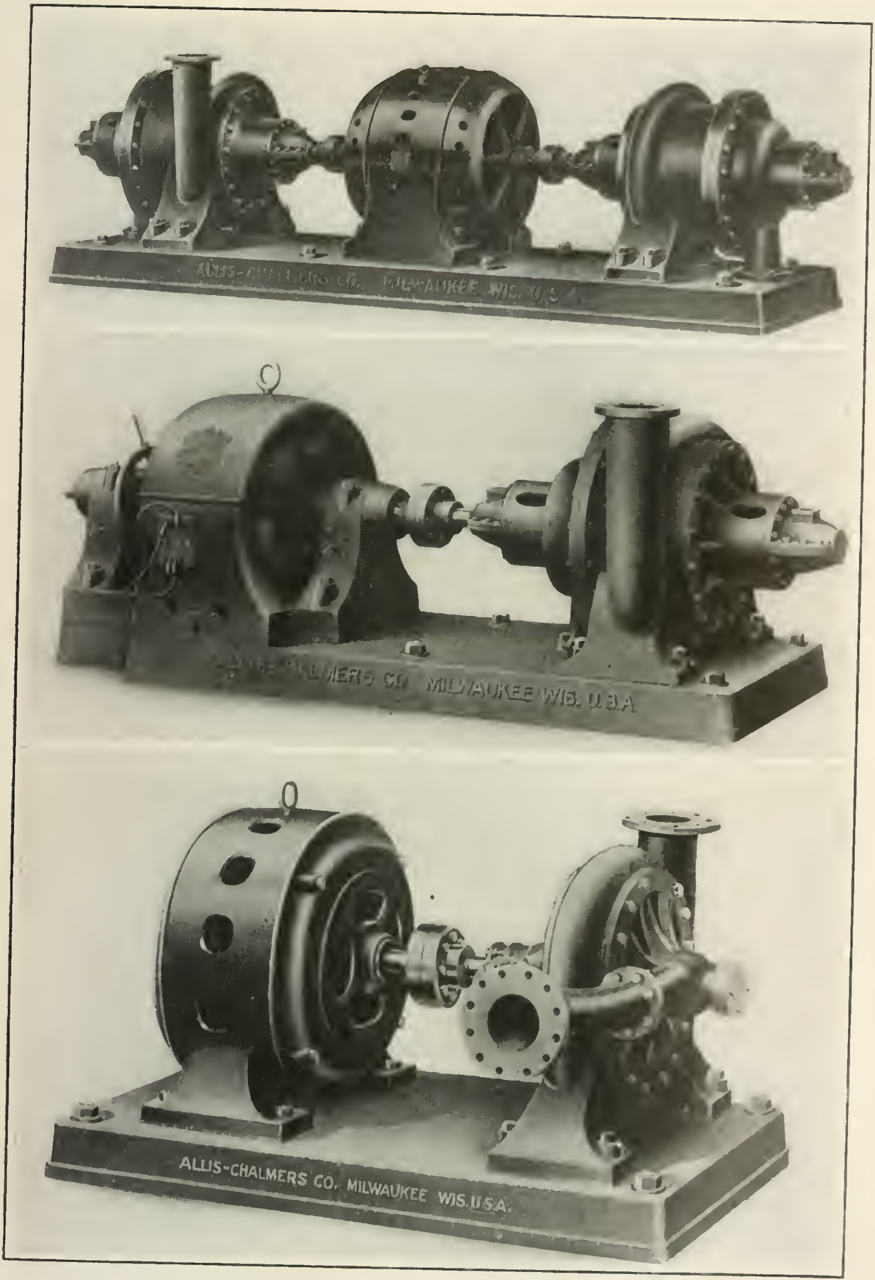


AN ELECTRIC GENERATING UNIT FOR THE MINE POWER PLANT.

A 400-kw. two-phase 6,000-volt 60-cycle revolving-field alternator. The Westinghouse Electric & Mfg. Co.

The use of electricity becomes still simpler and the responsibility less if instead of generating one's own power it can be purchased at a paying figure by the operator from some power company. This eliminates also the investment necessary for a local generating plant.

Electricity as motive power is exceptionally well adapted to the special and exacting requirements of mining and milling work. The cost of maintenance is less than in any other system of traction, the greatest saving being in cost of attendance as compared with either


ALLIS-CHALMERS CO. MILWAUKEE WIS. U.S.A.
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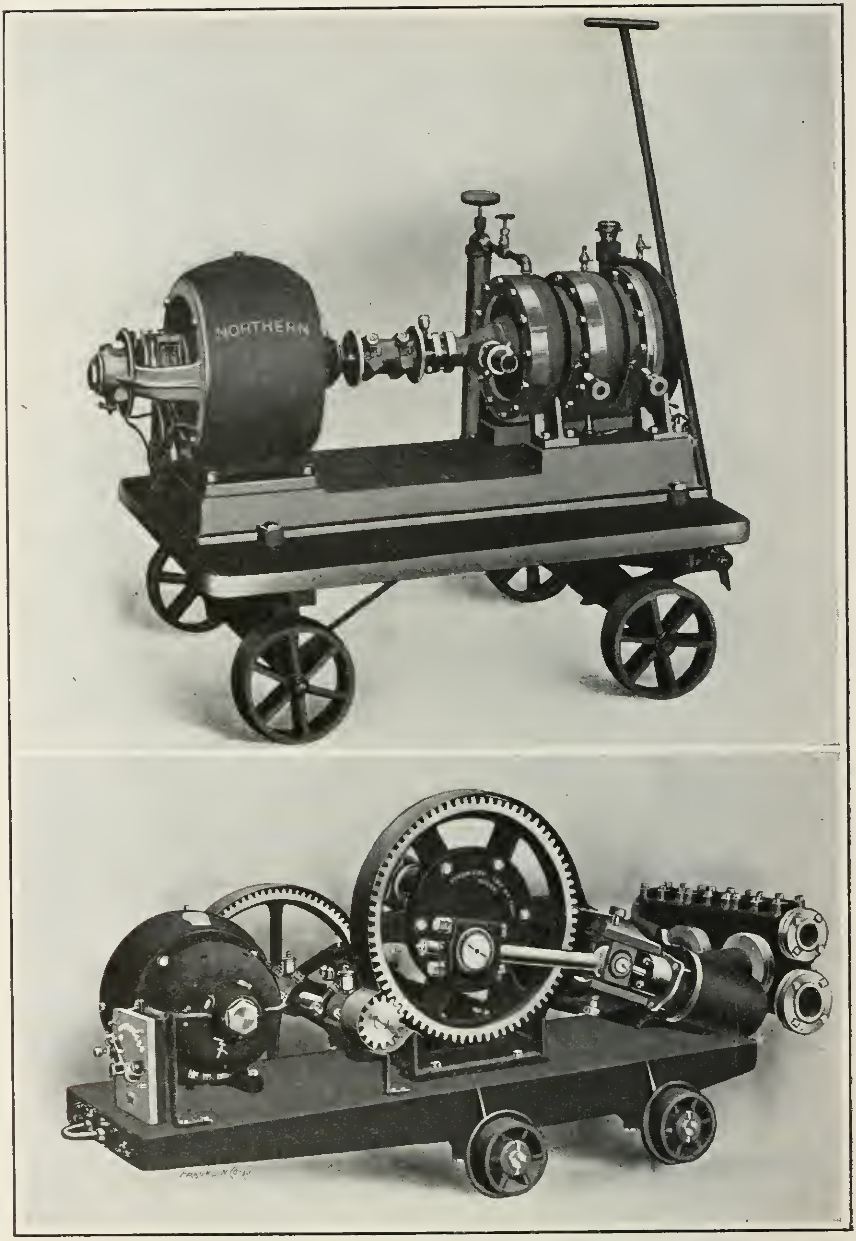
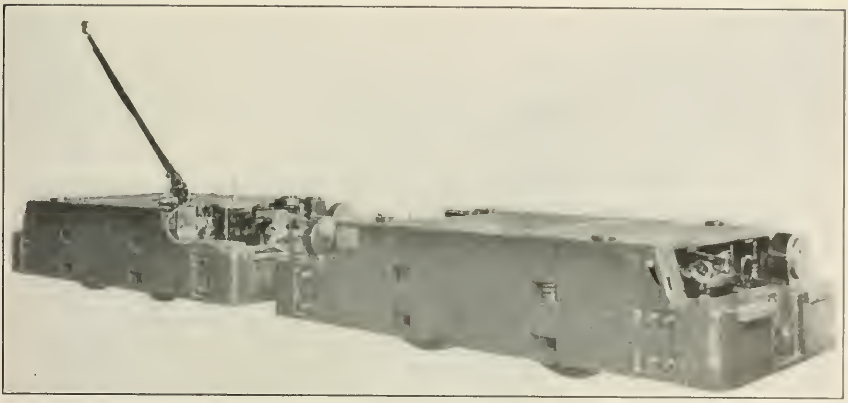
ELECTRIC-DRIVEN CENTRIFUGAL-PUMPING OUTFITS FOR MINING WORK.

Allis-Chalmers-Bullock machinery. The topmost picture shows two three-stage pumps in series, driven by induction moter; in the middle is a two-stage driven by direct-current motor; at the bottom, a single-stage driven by induction motor.



PORTABLE AIR-COMPRESSOR AND PUMPING OUTFITS WITH ELECTRIC-MOTOR DRIVE, FOR MINE USE.

The upper figure shows a three-stage centrifugal pump, built by the Byron-Jackson Machine Works, San Francisco; the lower shows an air-compressor mounted on a truck for mine service. Both are driven by Northern Spherical motors, built by the Northern Electrical Mfg. Co., Madison, Wis.

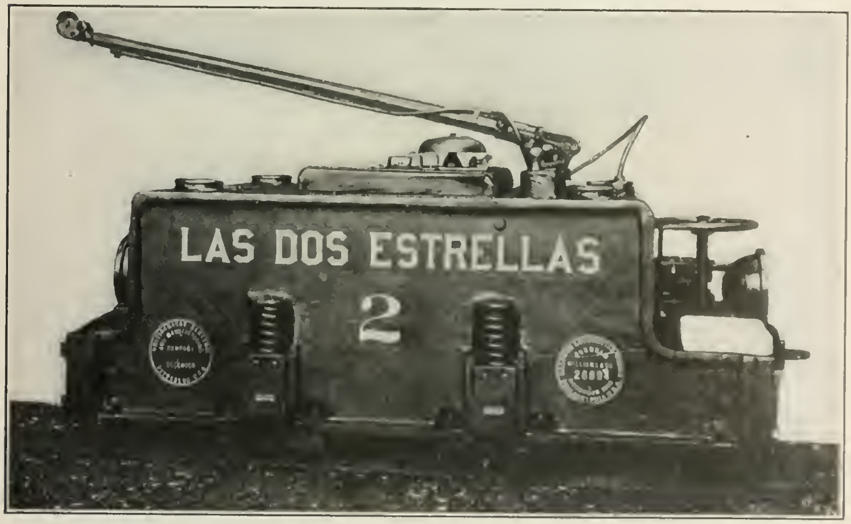


GENERAL ELECTRIC TANDEM LOCOMOTIVE FOR MINE WORK.

Weight 25 tons distributed in two machines for heavy haulage work. Suited for negotiating short curves, on account of short wheel base of each unit. Control of all motors effected from one controller. Units may also be used singly.
General Electric Co.

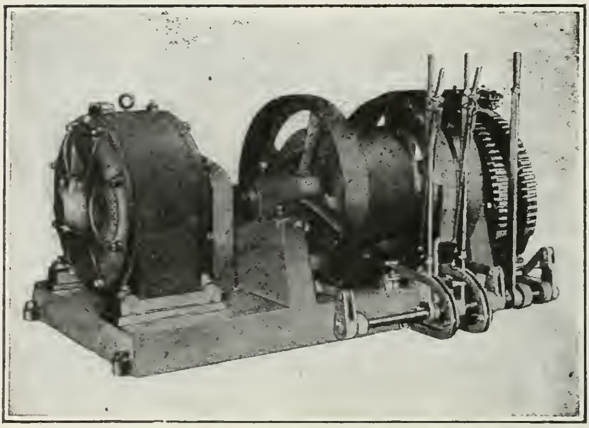
animal or mechanical haulage. The absence of moving parts exposed to external injury, the easy accessibility of running parts, and the simple character of the mechanism of an electric locomotive, appeals to the user.

This saving would still obtain even in cases where mines are operated as is the mine of a certain manager who, in reply to a ques-



AN ELECTRIC MINING LOCOMOTIVE FOR USE IN MEXICO.

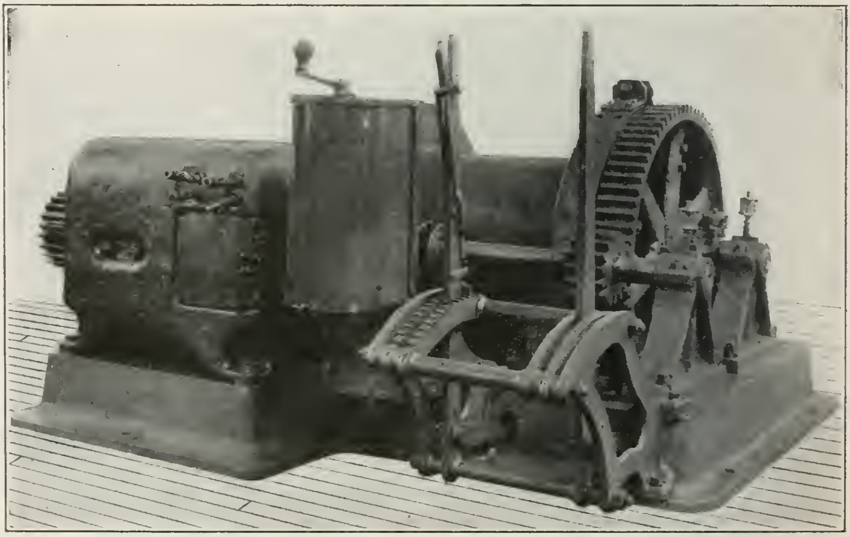
Westinghouse Electric & Mfg. Co., and Baldwin Locomotive Works.



SINGLE-DRUM MINE HOIST DRIVEN BY WESTINGHOUSE ALTERNATING-CURRENT INDUCTION MOTOR.

tion as to what kind of locomotives he used for hauling ore, remarked that his locomotives "all wore pants."

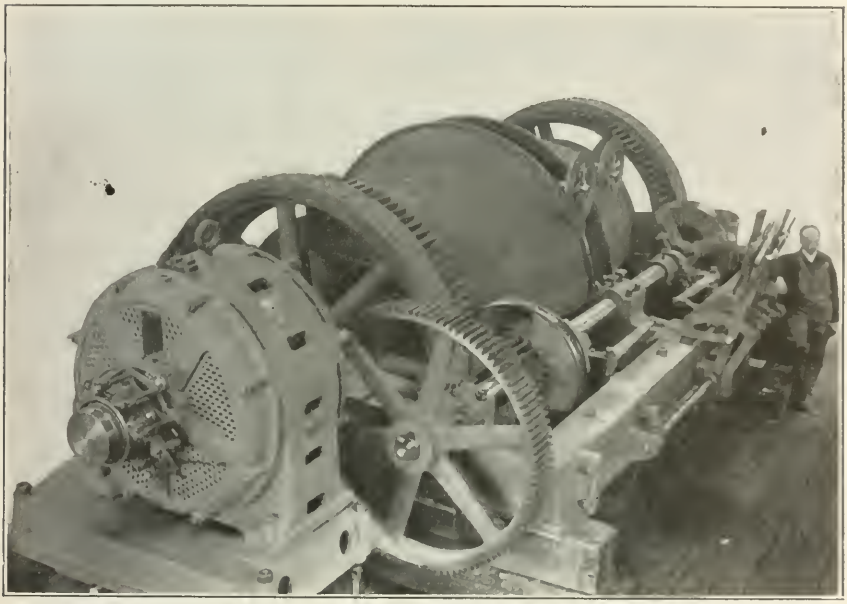
Although the steam hoist was welcomed warmly as a substitute for the hand hoist and horse whim, the electric hoist now so widely adopted is a vast improvement over previous methods. No local boiler plants, engines, long steam pipes, etc., are necessary, all this this being replaced by but three or four wires and the motor with its controller, which occupy but little room outside of the hoist proper. With an electric hoist, the controlling and varying of motor speeds is easily accomplished, the whole being readily located wherever desired, and moved from place to place as a complete unit conveniently, if not too large.



AN EXETER HOIST DRIVEN BY CROCKER-WHEELER MOTOR.

A 60-horse-power series-wound motor with reversing controller, having fourteen speeds in each direction. Capacity of hoist 20,000 lb., 70 ft. per min.

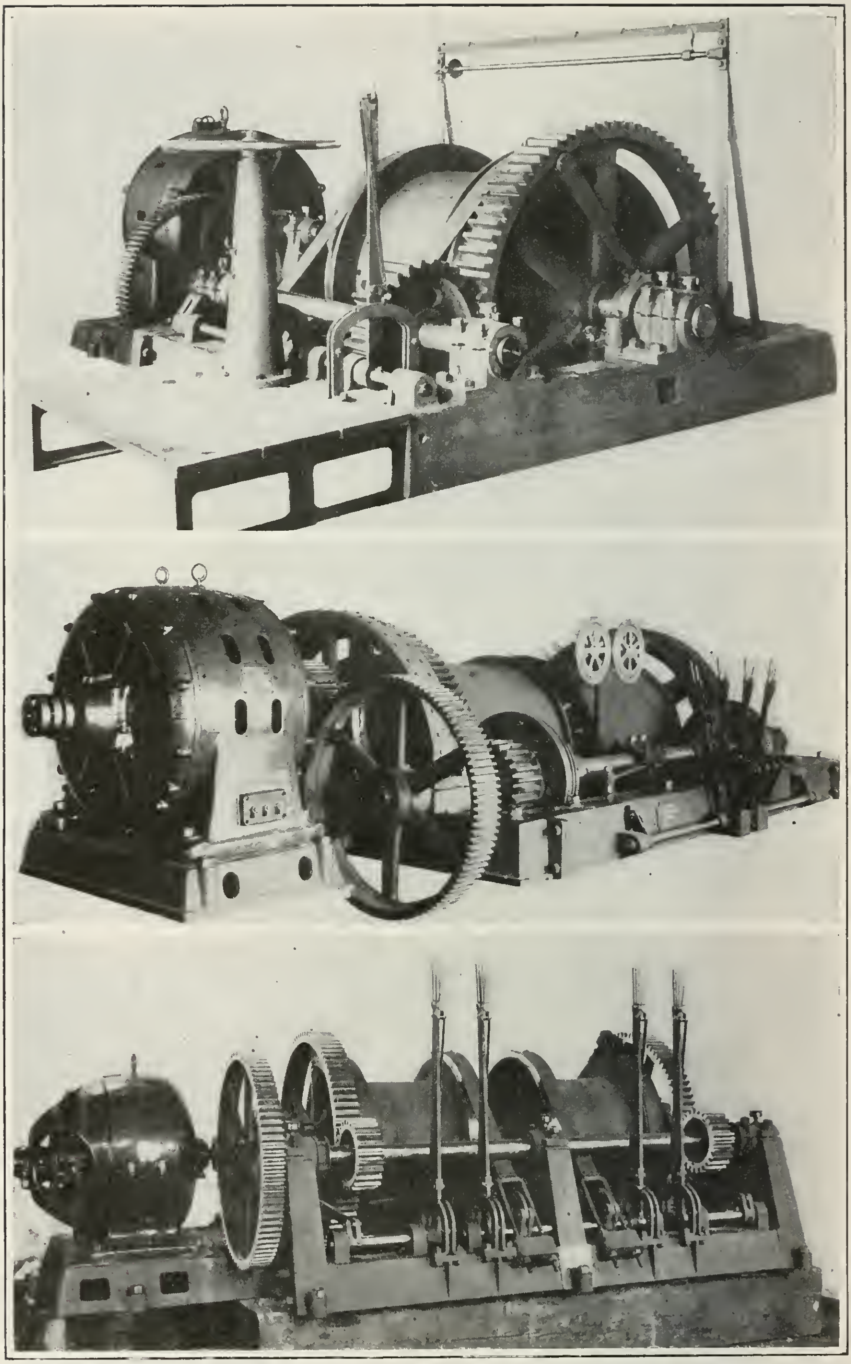
As to economy, I might cite a gold mine where steam hoisting has been superseded by electricity. The electric hoist elevated the cage at 1,250 feet per minute, raising 500 tons daily from a 2,500-feet level by double-deck cages, carrying 3,600 pounds of ore. Up to the time electricity was adopted, the cost of motive power was never less than $20.00 per horse power per month; after that time, it cost $7.00 per horse power per month.



A MODERN ELECTRIC-DRIVEN MINE HOIST.

Double-drum 150-horse power hoist built by the Denver Engineering Works for installation in the Guanajuato district. Equipped with Westinghouse motor.

Pumps and compressors require practically constant torque, or turning moment of a motor. The electric motor has been most successfully applied to plunger and centrifugal pumps at low and high speeds for all lifts and capacities. The motor is in every way economical, and has not many of the objections raised against steam pumps for mine and mill work. Although the centrifugal pump does not possess the efficiency of a plunger pump, its mechanical simplicity and low cost of maintenance win it favor in places where the conditions of service are severe, as is usually the case with mining work. One of these conditions is sinking. The service demanded of a sinking pump is extremely severe, for not only is the amount of water required to be pumped uncertain (no one knowing at what moment a large flow of water may be struck), but the head is continually increasing as the shaft grows deeper. It is necessary that the pump be

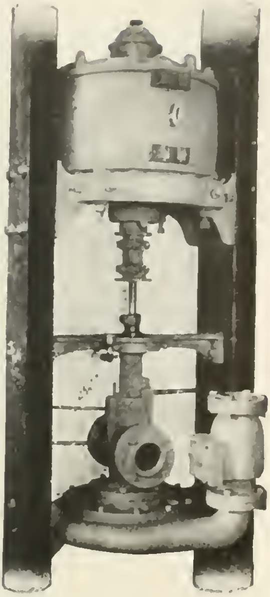


THREE EXAMPLES OF DENVER HOISTS.

The topmost is a 100-horse-power hoist, single drum with double brakes, operated by hand wheel, alternating-current motor, especially for long hauls on an incline. Below it is a 200-horse-power hoist with clutches on the intermediate shaft; General Electric alternating-current motor. At the bottom is a 15-horse-power double-drum hoist with direct-current motor. Denver Engineering Works.

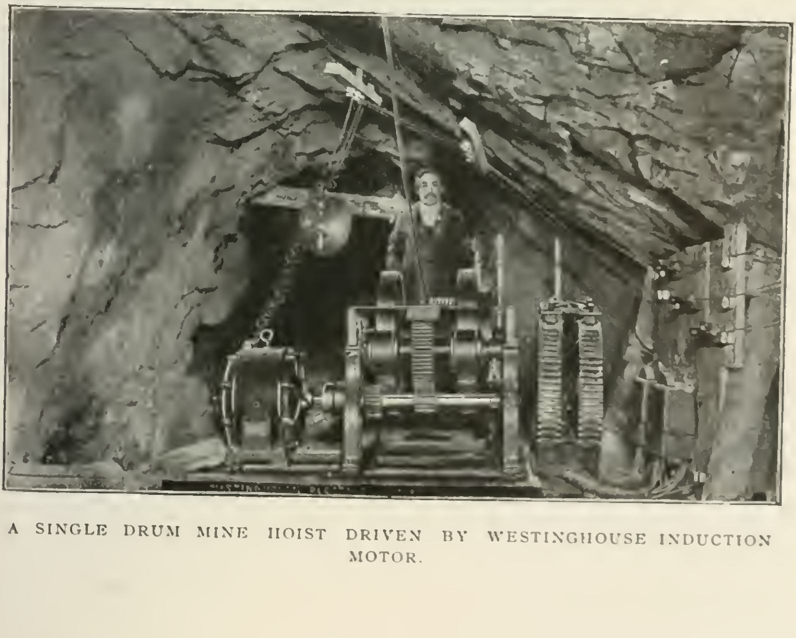
designed for some fixed head, even though the depth of shaft is constantly changing. Until this depth is reached it is necessary to throttle the discharge of the pump to prevent seriously overloading the motor. The advantages of an electric sinker over a steam pump are many, one of the principal being the substitution of wires for steam pipe. The unavoidable losses from condensation in long steam pipes in mining work with the steam pump become excessive, and the many opportunities for economy in favor of electric drive will readily be appreciated.

These electric sinkers are of late being perfected and are in much demand. With the centrifugal type of sinking pump, the motor and pump can be separated some distance, even to 100 feet or more, so that in case of a blast the motor is in a protected position, there being little exposure to injury about the pump proper. Centrifugal pumps are made to and over 100-horse power in size, operating successfully at 1,700 revolutions per minute under a head of 800 feet and more. This type of

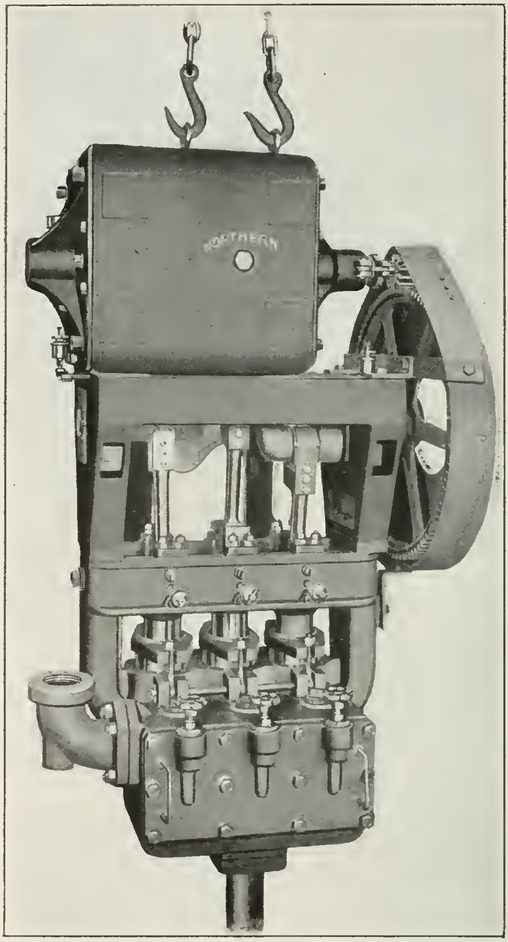


VERTICAL TYPE SINGLE-STAGE CENTRIFUGAL SINKING PUMP WITH ELECTRIC MOTOR.

Byron-Jackson Machine Works and Westinghouse Electric & Mfg. Co.



A SINGLE DRUM MINE HOIST DRIVEN BY WESTINGHOUSE INDUCTION MOTOR.



A SINKING PUMP WITH ELECTRIC MOTOR.

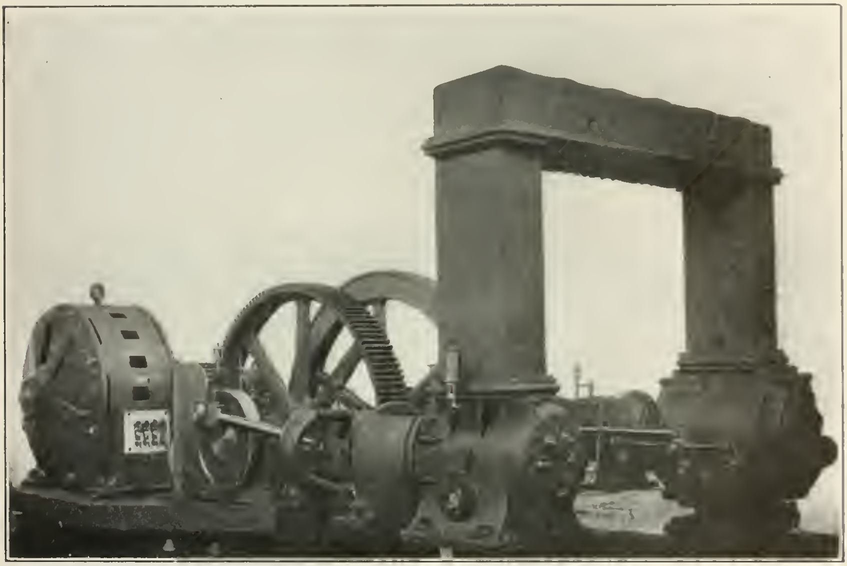
Northern submergible box-type motor of 5 horse power driving Allentown triplex sinking pump; 750 revolutions; the motor equipment is waterproof.

pump is also in use working entirely submerged.

It is to be regretted that the electric drill operated by an alternating-current motor has not been perfected, as its adoption would result in a great saving over the present method of carrying air pipes for long distances. Some electric drills using direct-current motors are on the market, but have not come into very general use outside of coal mining. The hard quartz in which gold is frequently found is more severe on these electric drills. In many cases the air from the drills is desirable for mine ventilation.

With steam-driven air compressors the question lies between the alternatives of locating the compressor near the boilers and piping the air, or near its place of consumption and piping the steam. With electric drive its location can always be at the most convenient point near the place of consumption. An installation of an electric motor in a California mine to take the place of steam power in driving a 100-horse-power air compressor resulted in reducing the cost of operation from an average of $1,800 per month to $672.

Fans and blowers as used in mines are required to run night and day in unfrequented places at considerable distance from the power house, with only occasional cleaning and oiling. This is a condition ideal for electric-motor drive, particularly the modern alternating-current motor which requires as little attention as any piece of apparatus that can well be made. Inasmuch as the power required to drive fans and blowers increases very rapidly with the speed, care should be taken to select a motor of proper size to obtain the full capacity from the fan. The highest efficiency of a fan is produced at a peripheral speed of about 5,200 feet per minute and is usually adopted where noiselessness is not essential. At 4,000 feet per minute fans are noiseless when direct-driven.



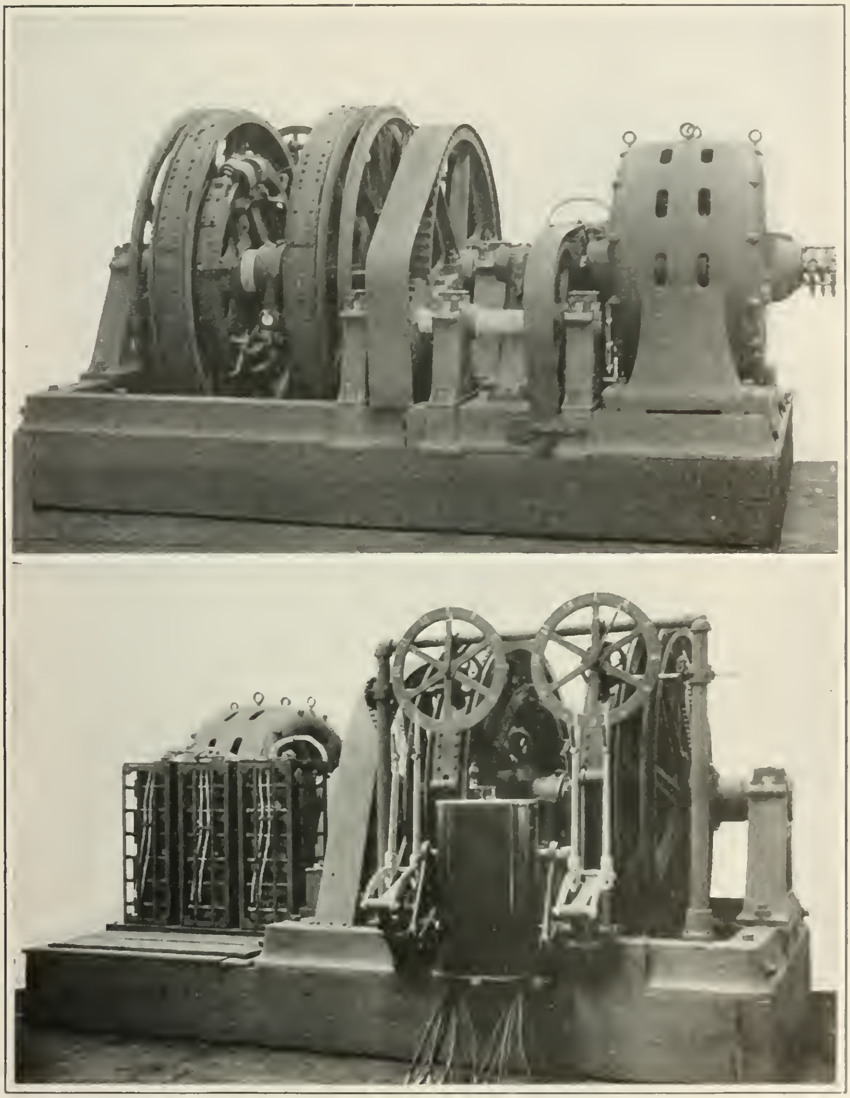
A LARGE ELECTRIC-DRIVEN AIR-COMPRESSOR.

200-horse-power Westinghouse induction motor direct-connected to Ingersoll-Rand compressor.

In the adoption of electricity in a mine or mill one of the first points to be decided is the system to be introduced, whether it shall be alternating or direct-current. In the case of a very small and concentrated plant never likely to enlarge, direct current could be applied. Nevertheless few installations remain small, particularly if the anticipations of a bonanza are realized. A direct-current plant is difficult to enlarge without large expenditures for copper wire. Furthermore, commutators and wire-wound armatures should be avoided where possible.

The conditions about a mine and mill lend themselves particularly well to alternating current as to lighting, hoisting, pumping, and driving the many constant-speed machines, such as blowers, fans, compressors, stamp-battery shafts, tube mills, cyanide-plant machinery, etc. It is true, direct current becomes necessary for the locomotives, but this is always a small percentage of the whole and can be easily obtained from an alternating-current motor-generator set. One of the advantages derived from an alternating-current system is the great convenience of readily transforming the voltage to whatever is desired, in case machines are to be driven at some distance from the power plant, and the resultant saving in the copper required to transmit the power. Undoubtedly the principal advantage is the possibility of using the squirrel-cage-type induction motor. This type of motor, properly constructed, has long been noted for the abuse it will stand. It has been compared to a grindstone in its simplicity. It will operate continuously without attention, and is provided with self-oiling bearings which require filling infrequently. It should be able to withstand excessive overloads, and be capable of being brought by an excessive

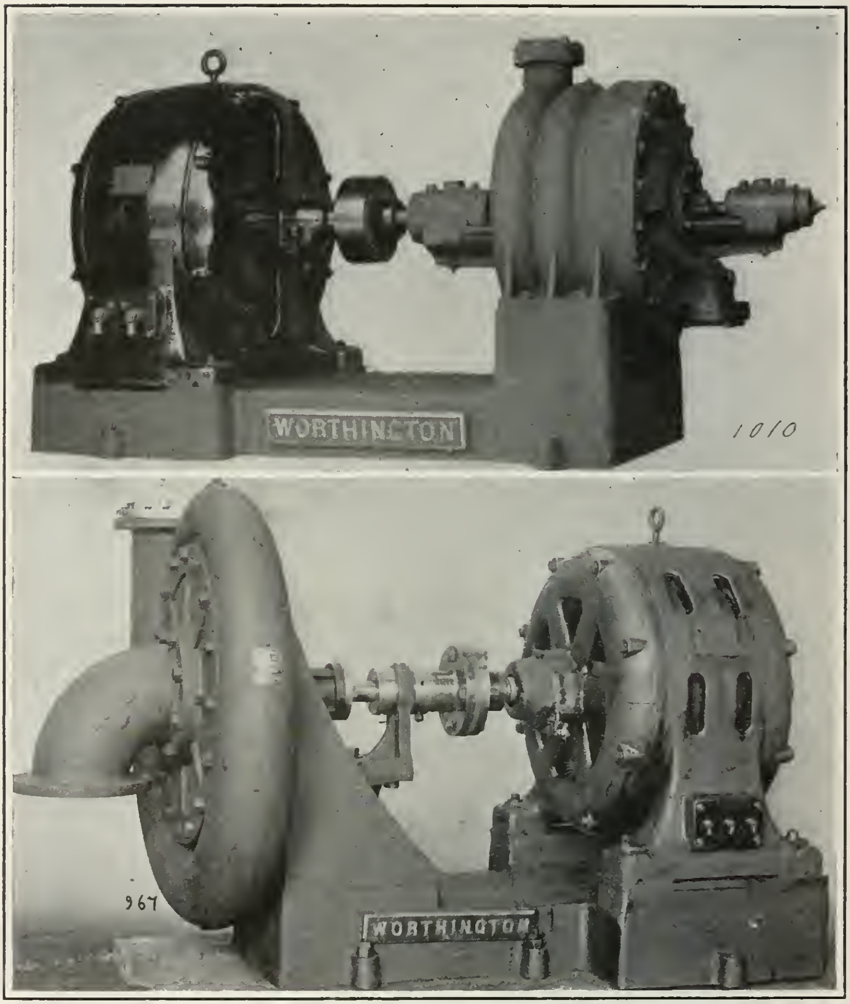
A 40-INCH REVERSIBLE STEEL-PLATE VENTILATING FAN, DRIVEN BY 10-HORSE-POWER WESTINGHOUSE INDUCTION MOTOR.



A MODERN SELF-CONTAINED DOUBLE-REEL ELECTRIC HOIST. FRONT AND REAR VIEWS.

Built by the Wellman-Seaver-Morgan Co. and equipped by the General Electric Co. for the Velardena Mining & Smelting Co., Velardena, Durango, Mexico. Hoists a load of 7,700 lb., of which 4,000 lb. is ore, from a depth of 1,000 ft. at an average speed of 550 ft. per min.; reels, 3 ft. and 8 ft. diam. Motor, 150-horse-power 550-volts. General Electric induction type.

overload to a full stop for a short time without injury. It has no brushes, commutator, slip rings, nor other moving wires or contacts, and is therefore entirely sparkless, so that no danger can result from fire. The motors are bar wound, instead of wire wound, which gives

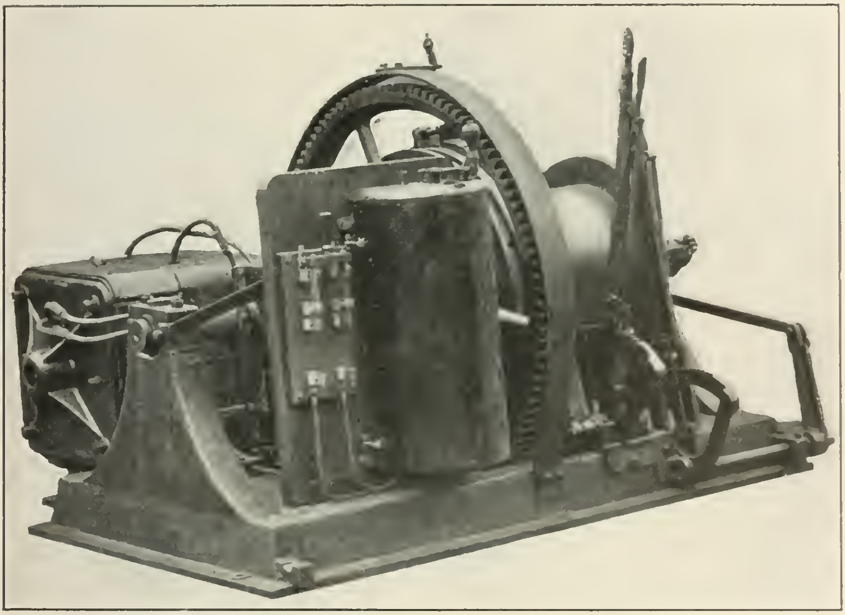


ELECTRIC-DRIVEN CENTRIFUGAL PUMPING INSTALLATIONS FOR MINING USE.

Electrical equipment by the General Electric Co.; hydraulic machinery by Henry R. Worthington, Inc. The upper unit is driven by a 50-horse-power direct-current motor, the lower by a 35-horse-power 440-volt induction motor.

an absolutely indestructible construction. They will withstand exposure to a reasonable amount of dust, dirt and moisture, and do not require skilled labor to start and stop them. The multipoint, oil-immersed auto-starters employed in starting them reduce the main-line current at starting to a minimum, which relieves the system and consumer's meter greatly, as well as the motor.

The extent to which electricity has been adopted corresponds very closely to the extent to which its possibilities and the profits following its introduction have become generally known. A parallel instance is the introduction of electric-power distribution in factories. This progressed very slowly until a sufficient number of factories had been equipped to make the superior merits of electric power everywhere manifest. No one now hesitates to equip a new factory with electric apparatus, and in hundreds of old factories the existing equipment of belts, shafts, pulleys, and other devices are being ruthlessly scrapped to make room for electric motors. The advantages of electric power over other means of transmission are even more decided in the field of mining than in manufacturing plants, and a rapid increase in the use of electrical machinery is taking place in all branches of the mining industry.

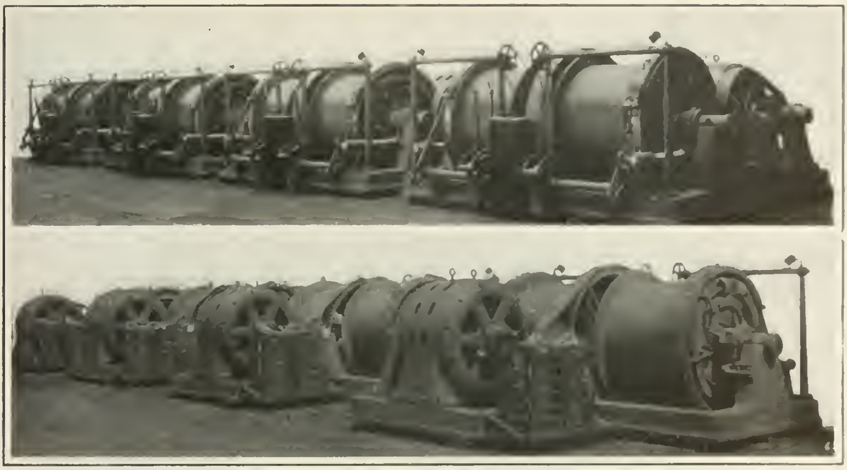


NORTHERN BOX-TYPE ELECTRIC MOTOR DRIVING GALENA HOIST.
Northern Electric Mfg. Co., Madison, Wis., and Galena Iron Works Co., Galena, Ill.

Among the many motors which comprise the equipment of an electrically operated mine and stamp mill practically all are constant-speed, except those operating hoists. If these latter are large in capacity in proportion to the total motor load or that of the local generating plant, they will be apt to prove the disturbing feature of the system, on account of the heavy currents drawn from the line at the time of starting and accelerating the load, which occurs very frequently. The effect on the line can be modified by many resistance notches on the controller, but as the operator always desires to make the greatest number of trips possible per hour and to accelerate quickly, he does not tarry long on the first few controller notches. This is not so injurious to a system and does not disturb the other motors and lights as much in a plant with ample generating capacity located near at hand; it is, however, a very serious objection where the electric power is transmitted many miles from a distant source. The current in a line feeding many induction motors is always lagging, the effect of which on the regulation of the generator is to demagnetize its field and thus reduce its terminal voltage. These surges thrown on the circuit of a transmission line by large induction hoist motors magnify the effect, producing poor regulation over the entire system. This might become so severe as to throw the synchronous motors, if any on the circuit, out of step. Two or three methods of overcoming this troublesome feature have been proposed; one which has proven very successful abroad in connection with hoisting work has recently been introduced into America for the first time, and will be described in a following article as applied to some hoists in the El Oro district of Mexico.

The usual form of alternating-current induction motor, which is most simple and in general use everywhere on American hoists, has a coil-wound secondary and a very high starting torque. At starting an external resistance is connected in series with the secondary winding. This is cut out, step by step, until the secondary winding is short circuited, when the motor runs at a practically constant speed and with very good efficiency. The drum type controller for this type of motor consists of a main drum with contacts arranged so as to cut the resistance in and out, and a second drum by which the motor connections may be reversed and the primary of the motor thrown on and off the supply circuit, both drums being operated by a single handle on the top of the controller.

To counteract the lagging current or low power-factor effect on the generating system, some power companies selling power to mines or mills located at long distance from the source require that all motors above a certain size, especially those of variable speed, shall be of the synchronous type. These can be designed to give a leading current or power factor of say 80 per cent by variation of field strength, which if comprising about one-half the total load (which is rarely the case) would give a resultant power factor close to the ideal

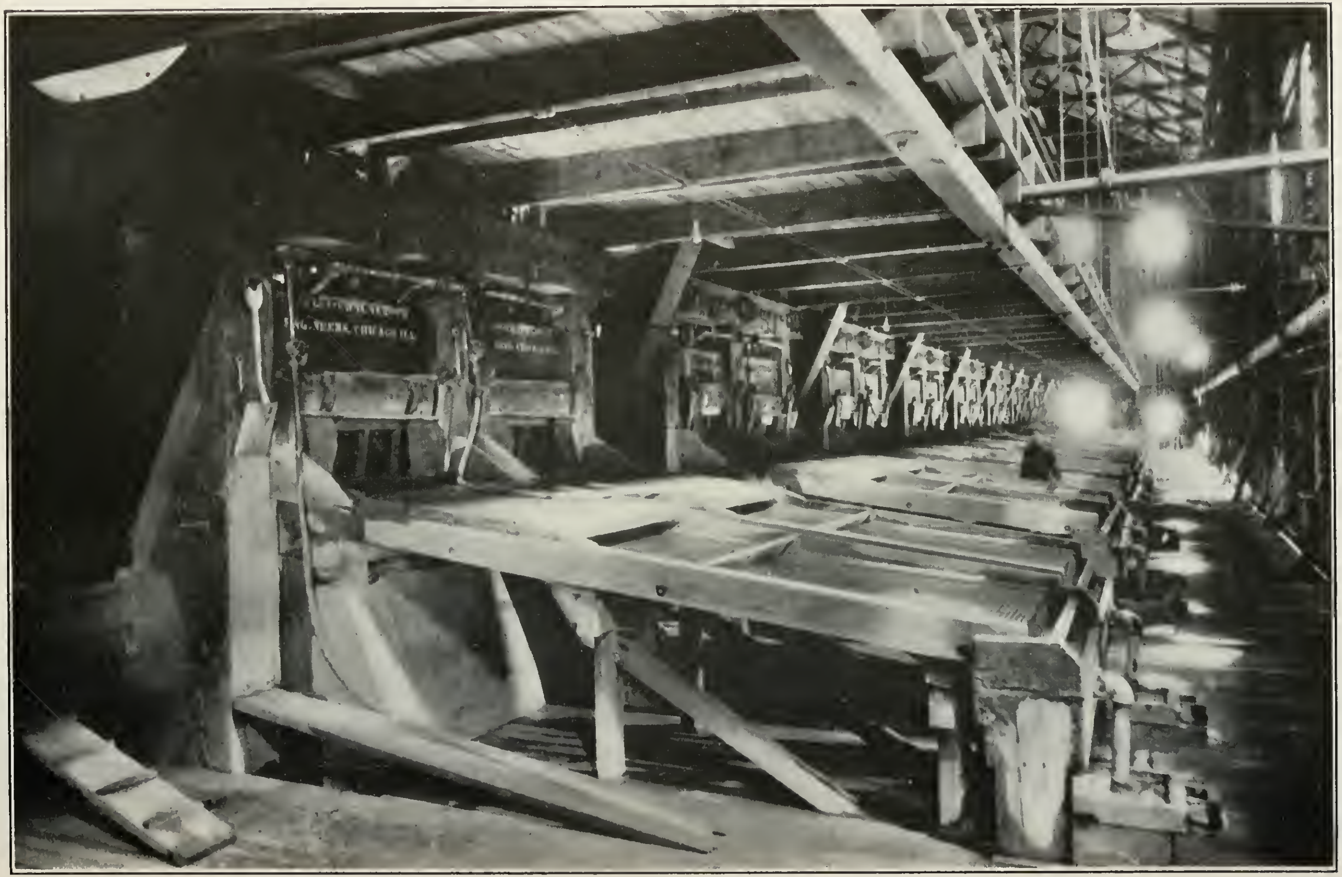


FOUR SELF-CONTAINED DOUBLE-REEL ELECTRIC HOISTS.

Built for the Velardena Mining Co. by the Wellman-Seaver-Morgan Co. and the General Electric Co. Hoist from a depth of 1,000 ft. at an average speed of 550 ft. per min.; load 5,100 lb. total, 2,000 lb. ore; drums 54-in. diam., 36-in. face; induction motors of 100 horse power, 550 volts.

100 per cent so much sought by all power-plant operators. The usual machines eligible to synchronous-motor drive in such service as we are considering, in mine and mill, would be the compressor, large motor-generator sets where much direct current is wanted for locomotives, main motors driving stamp-battery shafts, etc. Any of the motor-driven machines could be so driven say where the motors are above 100 or 200-horse power in size.

In order that the synchronizing power of such synchronous motors may not be sacrificed by making them self-starting, they should be started by small auxiliary motors, similar to the induction type of hoist motor referred to above in conjunction with a controller and resistance having several steps. Considerable care should be taken in the specification of a synchronous motor to be placed on the end of a long-distance transmission line. A motor of this type operating on a circuit with varying disturbances tends to follow these disturbances, or "hunt" as it is called, and in the extreme may even drop out of synchronism and stop. The only remedy for this is an application to the motor of what corresponds to a governor—or a flywheel—on an engine. In the case of the motor, "dampers" are the governor. These consist of heavy copper castings in the form of grids entirely surrounding and also cutting the surface of the poles of the motor. They are like a transformer secondary, there being developed in them local currents, induced by line fluctuations, which currents in turn react to reduce the fluctuations. The steadying effect of a large motor of this

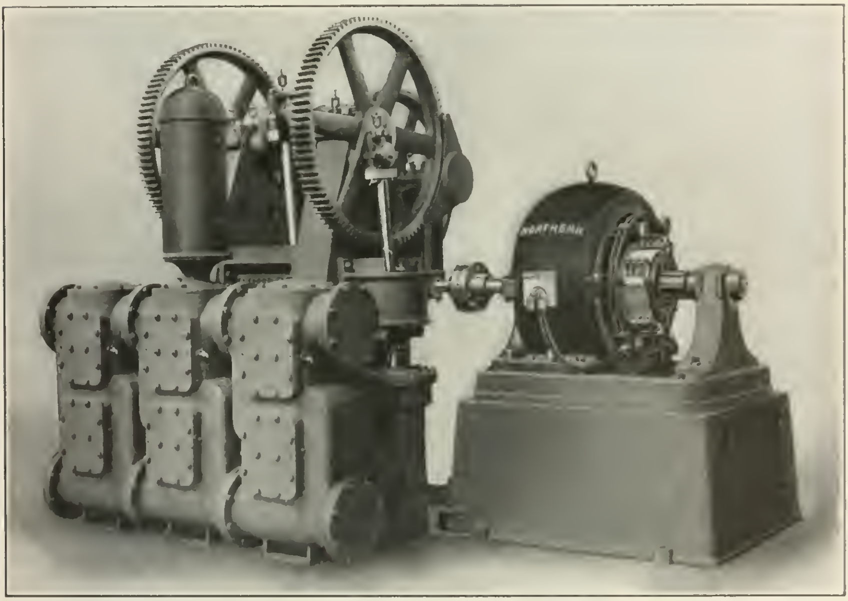


A MODERN MEXICAN STAMP MILL, 100 STAMPS, DRIVEN BY ELECTRIC POWER.

Originally installed by the Allis-Chalmers Co. as a steam mill, and electrically equipped by the Westinghouse Electric & Mfg. Co., El Oro, Mexico.

type properly fitted with these heavy dampers is very marked and beneficial to the system.

These precautions with the motor do not give their best results, and may all be for naught, if similar steps are not taken with the generators by providing them also with dampers to correct for speed fluctuations and tendency to field distortion resulting from line and load disturbances.

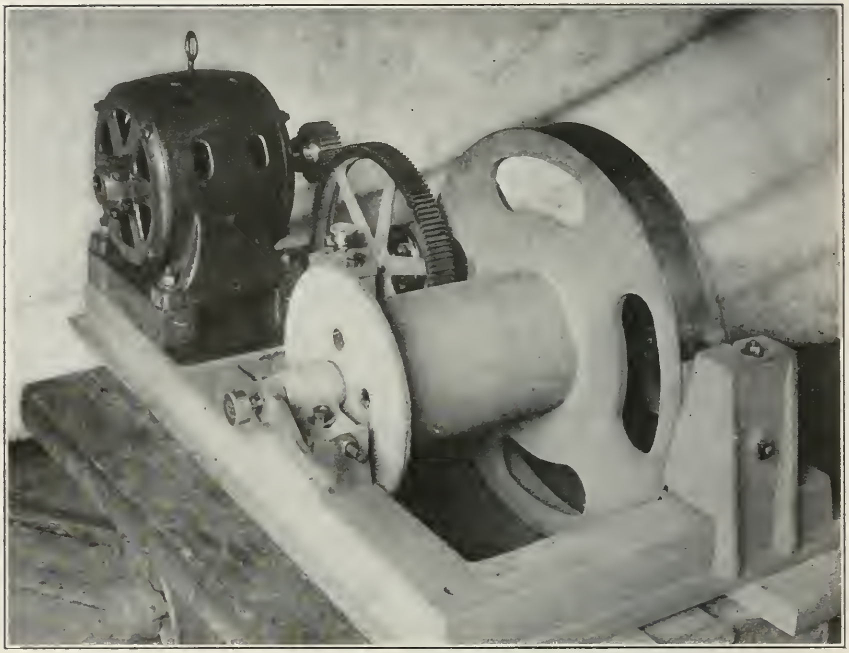


ELECTRIC PUMPING MACHINERY FOR A MODERN MINE.

Northern ring type motor of 50 horse power driving Goulds triplex pump, 11 by 12. A change gear in the back of the pump affords speed variation.

Naturally a synchronous motor requires more attention in starting, is more sensitive to abnormal or emergency conditions on the circuit, and is more expensive than a straight induction motor. If built to give a large leading power factor, a larger machine is also necessary. The popular general use of the induction motor has arisen largely from its simplicity of operation, together with the extreme amount of abuse it will stand in any kind of service—more than any other kind of motor made. It is evident synchronous motors should only be adopted for the larger sizes, and that the generaors should have good inherent regulation, especially if the motors on the system are large in proportion to their size, and the load fluctuating.

In the equipping of stamp mills the more usual practice is to drive the main shaft in sections, which in turn drive the cam shafts so as to



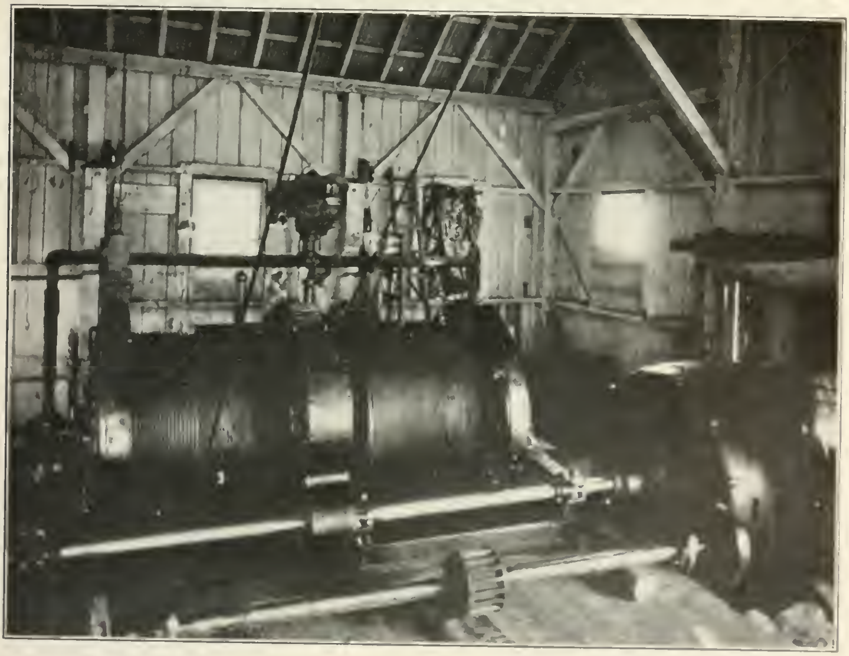
AN ELECTRIC WINZE HOIST.

Made in 1 to 3-horse-power sizes. Designed especially for the Compania Minera de Penoles de Mapimi, Durango, Mexico, by the Denver Engineering Works. About forty of these hoists have been installed.

give from 100 to 104 drops per minute to the stamps, there being two drops of the stamp to each revolution of the cam shaft. There are probably more mills equipped with 50-horse-power motors driving units of 20 stamps each, though a few are operating with 100-horse-power motors on 40 stamps and some with 350-horse-power synchronous motors driving an entire mill of 100 or 120 stamps. In almost all such installations as the last referred to the mills were formerly driven by steam, and the steam connections are left as much intact as possible, if for any reason it should prove desirable or necessary to drive by steam for a short time. This of course means considerable friction loss in long line shafts, and means the shut down of the entire mill in case of trouble with motor or transmission. There is little doubt but that such drives will in time be changed to unit drives as confidence is established in continuous electrical service, which is comparatively new for this work; then the steam engine and boiler plant will be divorced entirely.

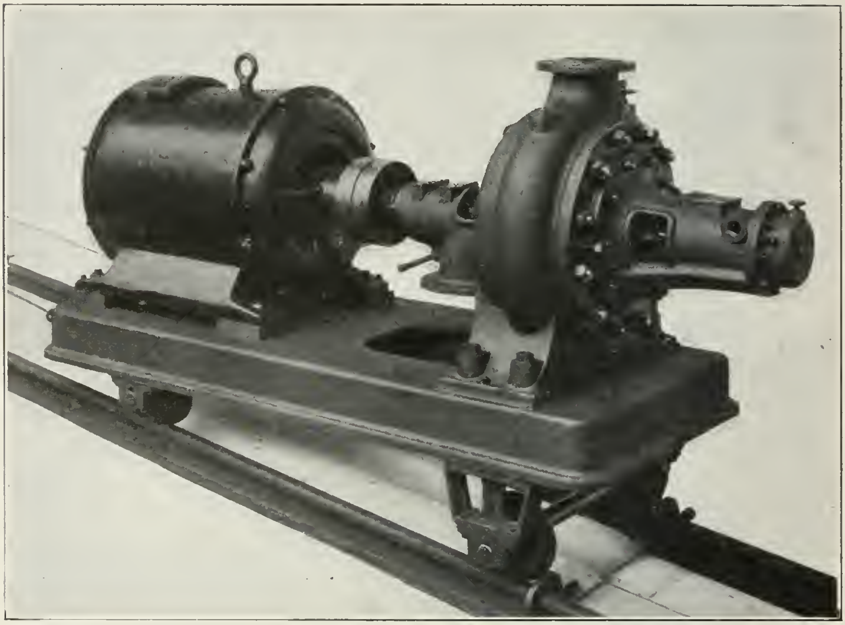
The ore-crushing plant about a mill is a simple application of an induction motor of proper speed and horse power, depending on the size and type of crusher used. One or more can be belted to the motor, or to jack shafts driven by the motor. With this type of motor two pulleys can be placed on the motor shaft, extended on both sides to drive two crushers, if desired. The flywheel of the crusher, together with the flywheel capacity of the motor rotor, is ample, with the proper capacity motor, to withstand the heaviest shocks due to large or hard ore.

Small electric locomotives, motor-driven belt conveyors, or ore cars pushed by hand, are employed in distributing the ore from the crushers to the various ore bins above the stamps. The sands from the stamps after passing over the amalgamating plates, next enter the tube mills for still further grinding. As to whether or not this second pulverizing or grinding is profitable is determined by the class of ore being handled, the object being to divide the sand so finely that the cyanide, in the treatment later, can get at and combine with the greatest possible amount of the gold. The economical point of regrinding is reached when the difference between values obtained and the total cost of regrinding is only a few cents. These mills are cylindrical shape, varying in diameter and length according to



A DOUBLE-DRUM SINGLE-REDUCTION ELECTRIC HOIST CHANGED OVER FROM STEAM DRIVE.

The old steam-driven pinion shaft is seen in the foreground. The new electric equipment is by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.



TWO STAGE ELECTRIC-DRIVEN CENTRIFUGAL PUMP FOR USE IN A MINE DRIFT.
1,440 revolutions, 46 brake-horse-power; Gebrüder Sulzer, Winterthur, Switzerland.

capacity. They are of heavy iron construction with steel or stone linings.

When designing a plant and laying out the motors for it, great care should be taken to select motors which are adequate to meet the starting conditions that will be encountered.

In a cyanide plant, the ideal condition is the application of individual motors to each machine, or small group of machines, as in the case of the mechanical agitators. By this method any one machine may be stopped when no work is to be done, or when repairs are necessary.

THE WORKING MAGNESITE DEPOSITS OF CALIFORNIA.

By Frank L. Hess.

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MAGNESITE, while not a common mineral, is found at a considerable number of places in different parts of the world associated with large areas of serpentine, peridotites, and pyroxenites. The principal foreign deposits now worked are in Germany, Austria, Greece, Italy[a], Norway, and India[b]. Unworked deposits are known in Lapland, Sweden, Russia, Africa, Australia, Quebec[c], British Columbia, and Mexico; of these the deposits in Quebec may be altered sedimentary rocks.

In the United States the most important occurrences are in California, with lesser ones in southern Oregon, Nevada, Pennsylvania[d], Maryland[e], and Massachusetts.

The Pennsylvania and Maryland deposits were at one time worked in a small way and the product used for making Epsom salts and other chemicals, but magnesite from Austria and Greece can now be imported so cheaply that they no longer pay to operate.

In California there are many deposits scattered along the Coast Range from the Oregon line to below Los Angeles, with a few along the foot-hills of the Sierras. Deposits are worked near Livermore and Porterville, and mines were formerly operated at Chiles Valley, Pope Valley, and, in a desultory way, at other points. The four places mentioned were visited by the writer in November, 1905.

Composition and Uses.

Magnesite, as it occurs in the California deposits, is a beautiful white, fine-grained rock, with a conchoidal fracture that looks like a break in fine china. It is magnesium carbonate, $MgCO_3$, and is about one-third harder and heavier than calcite. It contains 52.4 per cent of carbon dioxide (CO_2) and 47.6 per cent of magnesia (MgO). Like limestone, it gives off carbon dioxide upon burning, and it is used for producing this gas, as the proportion contained is much greater than in limestone, which carries but 44 per cent. The residual magnesia left upon burning is also more valuable than the lime left upon burning limestone, and the amount of heat required to drive off the CO_2 is less. The burned magnesia (MgO) is used for making refractory brick for use with basic slags, as in copper smelting and some steel making, as an adulterant in paint, and medicinally. After being changed to the sulphite it is used in the digestion of wood-pulp for paper. The light carbonate, known also as *magnesia alba levis,* is employed for medical and toilet purposes, and with varying amounts of asbestos (15 to 50 per cent of the whole) for pipe coverings and boiler lagging. As the sulphate it is known as Epsom salts, large amounts of which are consumed in warp-sizing or weighting in cotton mills, and smaller amounts in medicine. The chloride is used as a cement and the hydrate in sugar making.

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[a] D'Achiardi, Giovanni, La formazione della magnesite all' Isola d'Elba. In *Atti della Società Toscana di Scienze Naturali, residente in Pisa, Memorie.* Vol. XX., 1904, pp. 86-134, 3 plates.

[b] Eckel, Edwin C. Cements, Limes, and Plasters, their materials, manufacture, and properties. New York, John Wiley & Sons, 1905, p. 150.

[c] Hoffman, G. C. Rep. of the Section of Chemistry & Mineralogy, Ann. Rep., Canadian Geol. Surv., Ottawa, Vol. 13, 1905, pp. 14-19.

[d] Frazier, P., Jr., *Lancaster Co., Second Geol. Surv.* Pennsylvania, Vol. CCC., 1880, pp., 86, 97, 176-196.

[e] Bascom, F. The Geology of the Crystalline rocks of Cecil Co. In *Cecil Co., report, Maryland Geological Surv.*, 1902, pp., 96-97.

The low price of magnesite (about $6 per ton landed at New York City) makes its mining on the Pacific Coast possible only for the local demands unless manufactured into more valuable forms. The Rose Brick Company, a subsidiary company of the American Magnesite Company, has recently established a factory at Oakland with the intention of making brick for shipment to the steel mills of the eastern States, and other products will be manufactured by allied companies. The magnesite intended for brick will be burned in long, inclined, brick-lined steel cylinders, somewhat similar to those used for pyritic roasting. Crude oil will be used for fuel.

Description of Deposits.

The California magnesite deposits, so far as known, all occur as veins in serpentine, or similar magnesian rocks. By far the larger part are in the Coast Range, in the serpentines that stretch from Southern California into Oregon. These serpentines are probably Lower Cretaceous in age[a], and cover large areas, Becker[b] estimating that between Clear Lake and New Idria, a distance of about 200 miles, there is a total area of over 1,000 square miles of serpentine. Through a large part of this area magnesite veins of varying sizes are found.

[a] Fairbanks, Harold W. San Louis folio, No, 101, Geologic Atlas of the U. S., U. S. Geol. Surv., 1904, p. 6.

[b] Becker, Geo. F. Geology of the Quicksilver Deposits of the Pacific Slope. Monograph, Vol. 13, U. S. Geol Surv., Wash., D. C., 1888, p. 103.

Those large enough to be more or less workable are reported from many places in Mendocino, Napa, Placer, Sonoma, Alameda, Stanislaus, Santa Clara, Fresno, Tulare, Kern, and Riverside counties. Of these, the deposits in Placer, Tulare, and Fresno counties are in the foot-hills of the Sierras.

The serpentines of the Coast Range are ordinarily green or bluish, greatly broken and faulted, a solid block a foot in diameter being a rarity in many localities. They are derived from olivine-pyroxene rocks in which the amounts of the minerals have varying ratios at different localities. At Porterville, the only place along the Sierra Nevada Mountains at which the serpentines were seen, they also seem to be derived from an olivine-pyroxene rock. Instead of the usual green, the serpentine is here brown, and, as compared with the others described is remarkably solid.

Magnesite is formed from the breaking down of the serpentine, a hydrous magnesium silicate. Magnesia is dissolved by percolating waters carrying carbon dioxide, changed to the carbonate, magnesite, and precipitated in cracks and crevices as veins. The silica is carried away by the water and is often deposited in other veins as opal or quartz.

The magnesite frequently stands out prominently from the surrounding serpentine, since it weathers less readily than the serpentine, and the surrounding serpentine is generally considerably decomposed and so erodes rather easily.

Little is known of the depth to which the veins extend. Considering that they are formed through the influence of percolating surface water, it seems fair to assume that the deposits may extend down to the limit of circulation of these waters, their size being modified by the time through which such circulation has existed, differences in the hardness or composition of the rock, etc.

Cinnabar and chromite are frequently found accompanying the serpentines in the neighborhood of magnesite deposits.

Livermore Deposits.

Near Livermore, a town forty-eight miles southeast of San Francisco, are a number of magnesite deposits, of which the only one being worked is located thirty-two miles southeast of the former place and belongs to the American Magnesite Company.

An excellent road follows up the Arroyo Mocho, crossing into and running down the Arroyo Colorado. The maximum grade for the haul from the mine is said to be 3 per cent. At the mines the company has erected good buildings and roads and an aerial tram 2,500 feet long, with a capacity of 100 tons per 10-hour day, delivers the magnesite to bunkers, from which it is loaded into iron wagons for hauling to Livermore. The wagons carry 17½ tons each, and two are hauled by an oil-burning traction-engine. The magnesite is shipped to Oakland, where the company's factories for brick, carbon dioxide, and other products are situated. The mine offices and other buildings are located near springs that give sufficient water for the needs of the engines, the mine, and other purposes.

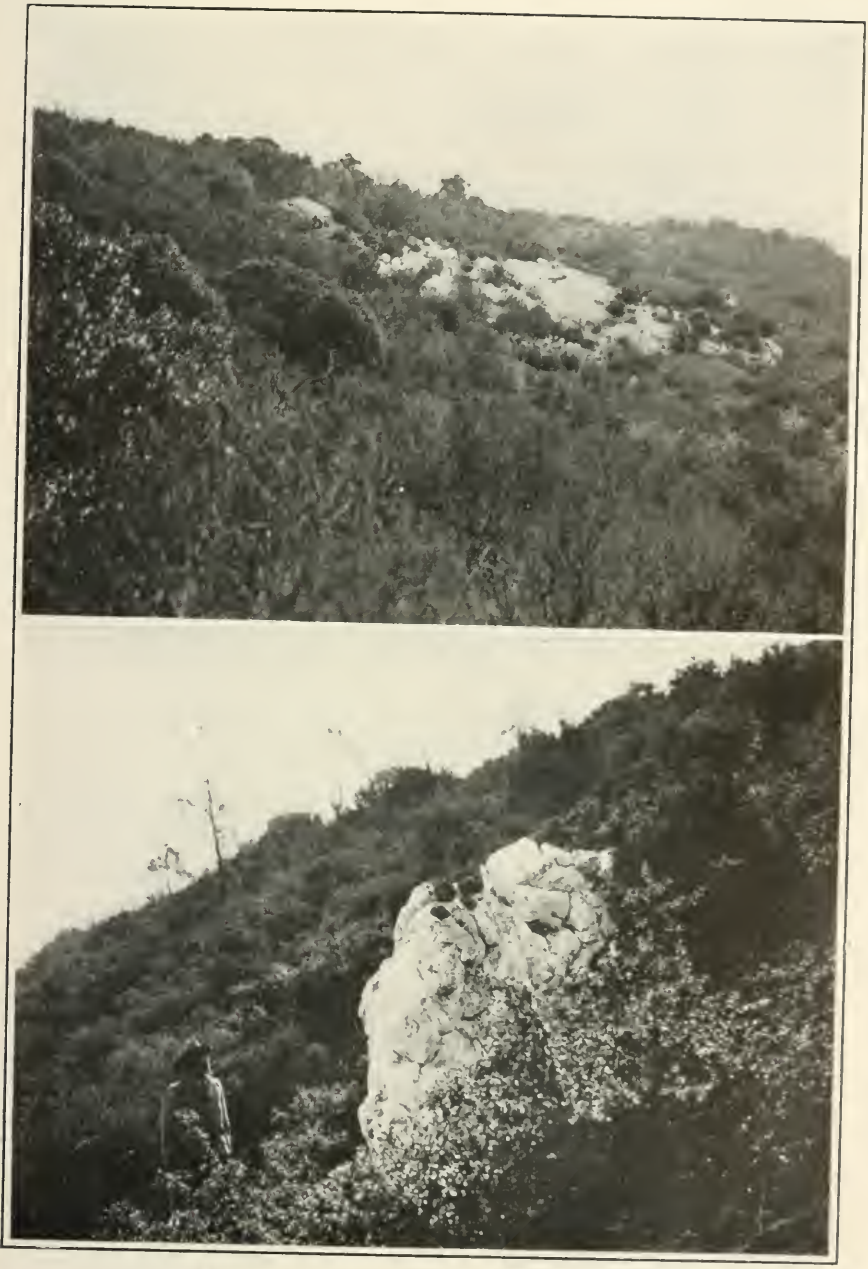
The magnesite veins stand out prominently in the bright sunshine of the valley and as they are almost dazzlingly white, they can be seen from the higher hills, miles away. One of the veins, called the "Mammoth," stands fully 10 feet above the hillside. Many of the veins, however, are largely covered by débris.

One of the veins shows an outcrop 40 feet broad and traceable through a distance of several hundred feet. Others show lesser outcrops, but the total amount exposed is large. However, in such outcrops but two dimensions are known and an estimate of the amount of magnesite available is merest guess-work.

Although these deposits have been known for a long time, they have not been worked until the past year owing to their distance from a railroad. There are a number of veins in a group around a small valley, so arranged as to be excellently located for working by adits and an aerial tram. The first magnesite was shipped from the mine in November. The vein that is being mined strikes about N 30 degrees W, dipping steeply southwesterly. It is pierced by several adits, on different levels, and a cross-cut at one place after entering the vein for 35 feet was not yet through it. A drill hole 8 feet long at the end of the cross-cut was said not to have reached the other side. The vein had been developed through a length of between 250 and 300 feet. The magnesite is pure and white, the cross-cut looking as if freshly whitewashed. As would be expected in a serpentine area, faults have occurred, cutting the vein in a number of places. Both hanging and foot-walls are fault planes.

Mining is carried on by means of an open cut in which the magnesite is quarried and allowed to fall through an upraise to an adit below, whence it is moved in cars to the aerial tram. The tram drops 600 feet in the 2,500 feet to the bunkers. The skips are placed 500 feet apart and each carries 1,000 pounds of magnesite.

Close to the magnesite veins about 250 yards southeast of the present workings are small impregnation veins of chromite. A small



FIGS. 1 & 2. OUTCROPS OF LARGE VEINS OF MAGNESITE.

The lower picture shows the Mammoth Vein on the American Magnesite Company's property, 32 miles southeast of Livermore, Cal.; the upper one is a large vein on the same tract and in the same vicinity.

amount of work has been done on the veins but the prospects did not seem to have been encouraging.

A little cinnabar is said to have been found in the neighborhood, and two mercury mines are being developed within a radius of four or five miles.

Chiles Valley.

Chiles Valley is situated in Napa County, and its nearest shipping point, Rutherford, is eighty-four miles by rail north of San Francisco. Magnesite was mined by Stanley and Bartlett for twelve years in the valley at a point about 10 miles from the railroad, but the mines have not been operated for the past five years, being too far from the railroad to compete with points more advantageously located with regard to shipping facilities. During the time that the mines were worked many thousands of tons of magnesite were mined and burned at this place. As pure magnesite loses more than half its weight on burning, a large saving could be made in haulage by getting rid of the carbon dioxide, if the material was to be used as magnesia. Manzanita, a hard-wooded shrub making a hot fire, was largely used for fuel.

The country-rock here is also the Coast Range serpentine, somewhat more inclined to a blue-black color than at the Livermore deposits. The deposits are on the west side of the valley, in a small serpentine hill skirted by a public road, and consist of a number of veins varying in thickness from 1 foot to 6 feet, but are said to have reached as much as 12 feet. Wherever seen, however, the larger ones were much mixed with serpentine and other impurities. Much faulting occurs with the veins, and both the hanging and foot-walls are generally fault planes. The serpentine is much broken in the neighborhood of the veins, the interstices being filled by small veins of magnesite.

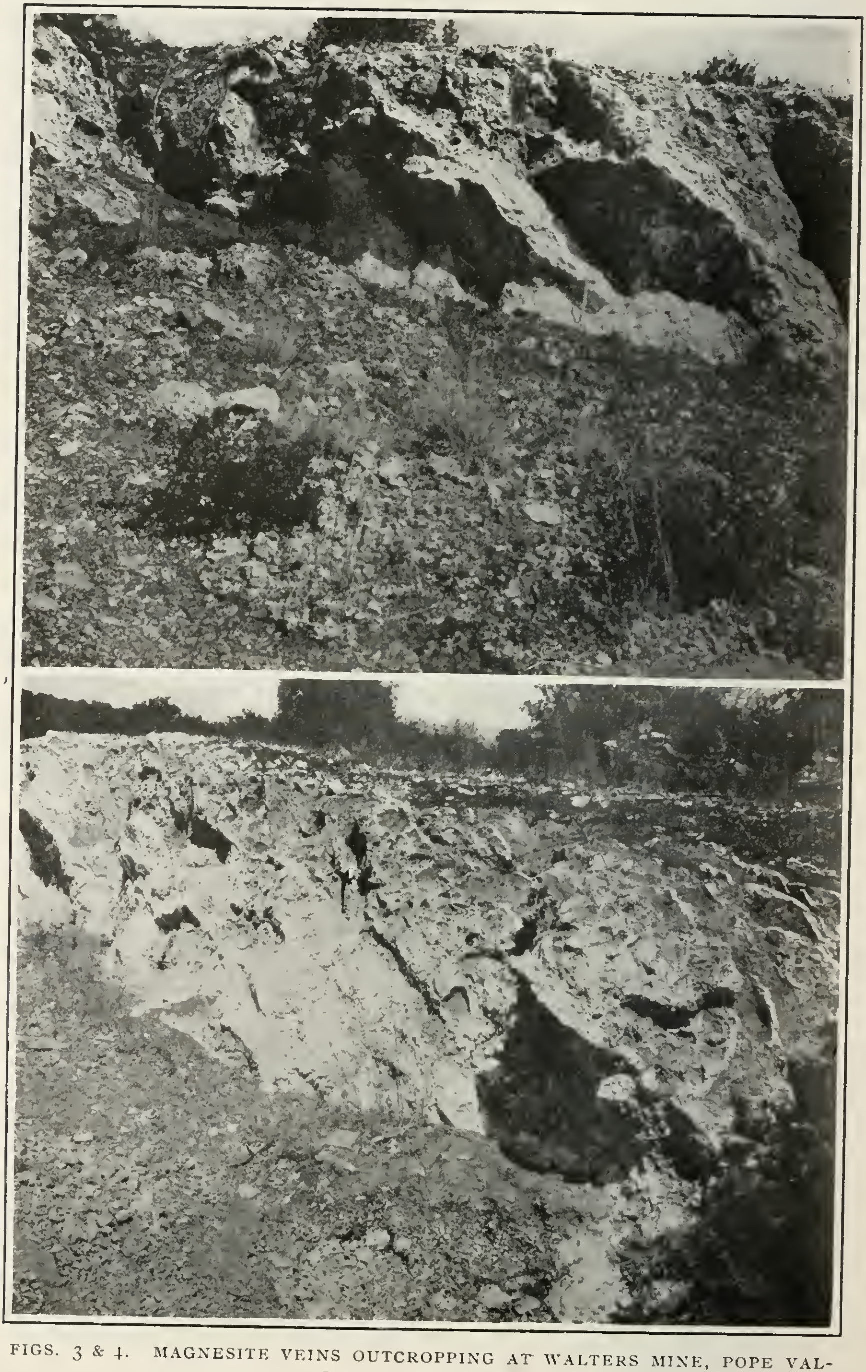
On the foot-wall of several of the veins extensive silicification has taken place, the serpentine being hardened through 2 or 3 feet. The veins are often brecciated and cemented with less pure material of yellowish color, while the original magnesite is a clear white. Frequently in the brecciated portions each fragment is covered by magnesite in radial crystals, forming a coating up to one-half an inch thick, and varying in color from crystal clearness to delicate green and yellowish-green. Cracks in the serpentine are also filled with the same crystalline magnesite. This form is strikingly different from the ordinary magnesite, which in these deposits shows no crystal form to the unaided eye. In places, crevices in the vein have a velvety black coating of pyrolusite (manganese dioxide) making the rock look as if it were coated with lampblack. A small amount of chromite has been found in the neighborhood, but not in paying quantities. An analysis of magnesite from this mine is given further along in this article.

Pope Valley.

What is usually known as the Walters magnesite mine is located on the east side of Pope Valley, twenty-two miles northeast of Rutherford. The distance of the mine from the railroad makes hauling expensive, and the mine has never been worked on a large scale and has had no production for several years. A proposed electric road from San Francisco to Lake County, if built, will pass within four miles or less of the mine, in which case it will be in an excellent position to ship magnesite.

The deposits are situated in a serpentine hill, about 400 feet (barometric measurement) above the valley. They are composed of a large number of veins, whose exposures vary in width from a fraction of an inch to 12 feet, and lie on both sides of a small southerly running ravine which forms an amphitheatre, with an easy, straight grade to the valley, making an almost ideal place to work with an aerial tram.

The deposits are in three principal groups, two of which lie on the east side of the ravine and the other on the west. In the main group on the east side are three large veins of magnesite which can be definitely traced for distances of about 140, 250, and 230 feet respectively, with strikes of N 28 degrees, 30 degrees, and 45 degrees W. At their northern end the western and eastern veins are but 30 feet apart, with the middle vein probably converging with the eastern one. The dip of the western vein is shown by a shallow shaft to be 50 degrees easterly. The veins stand up boldly and can be seen from any part of the valley not hidden by hills. Longitudinal faults occur in both of the outer veins. Between the large ones are many smaller veins having a general parallelism to the main bodies. At its widest exposure the western one is about 10 feet thick, of which about 5 feet on the foot-wall is solid white magnesite, while the upper 5 feet (on the hanging wall side) contains many inclusions of serpentine. The structure of the east vein is similar, and in places the magnesite may be seen grading into the country rock. It is about 12 feet wide where exposed in a shallow cross-cut. In the middle vein a width of 18 inches to 5 feet of clear white magnesite is exposed. Some of these outcrops are shown in the photographs on the next page.



FIGS. 3 & 4. MAGNESITE VEINS OUTCROPPING AT WALTERS MINE, POPE VALLEY, CALIFORNIA.

There has been some crushing of the magnesite and the broken particles have been cemented with yellowish, less pure material. Part of the magnesite has formed in yellowish botryoidal masses that are rather impure. Some crystalline magnesite, similar to that of Chiles Valley, is found in the crevices. No large amount has been mined, and that was simply broken from the exposed faces of the veins.

A second group of veins with a more northerly strike occurs a hundred feet or more above the veins just described. The veins forming this second group are smaller, running from 2 inches to 2 feet in width, the larger ones impure. There are also many scattered veins in the intervening space.

On the west side of the ravine is a third group of veins 200 to 250 feet from those first described, with a strike between north and northwest. The largest is a vein 4 to 6 feet wide, and seven others from 1 to 2 feet wide occur within a space of 125 feet: all are of excellent quality. It would seem possible to blast out the whole of the rock through this distance and hand-pick it, should the deposits again be worked.

The Porterville Deposits.

The Willamette Pulp & Paper Company is working a large group of magnesite veins four miles northeast of Porterville, in the outer range of foot-hills of the Sierra Nevada Mountains. The veins occur in a brown serpentine, derived from an olivine-pyroxene rock with a structure resembling bedding. The serpentine forms part of a metamorphic complex of amphibolite-schist, serpentine, and other magnesian rocks, some talcose and mica-bearing, and a small amount of fine-grained quartzite. The rocks have a general northerly strike with a high dip (60 degrees) easterly. They are cut off by a granitic mass on the south, a few hundred feet from the deposits, and several granitic dikes cut the serpentine and other rocks. Basic dikes of several varities cut both the country rock and the veins, and are occasionally squeezed to schists.

Faulting is frequent and the magnesite in the larger veins is invariably crushed. In one vertical two-foot vein a couple of hundred feet southeast of the kiln, the magnesite has been so squeezed that it has taken a modified cone-in-cone structure; it is left in irregular fragments whose sides are covered with abrasion lines, and the whole looks as if at the time of crushing it had been in a semi-plastic state. In other veins the planes along which the magnesite has moved upon itself are smooth and shaped so as to somewhat resemble the curve of a highly arched shell. Along these planes is often a bright red stain of iron oxide, although the surrounding magnesite is pure white. At the northern end of the deposits are several "blanket" or flat veins. The largest one is practically horizontal in the middle part and somewhat uptilted at both ends. It extends through the hill, a distance of 362 feet, and is probably twice as long, and from 2 to 4 or more feet thick. A basic dike flattens and spreads under a large part of the vein in a thin sheet 1 to 2 feet thick; then breaking through, it overlies the remainder of the vein.

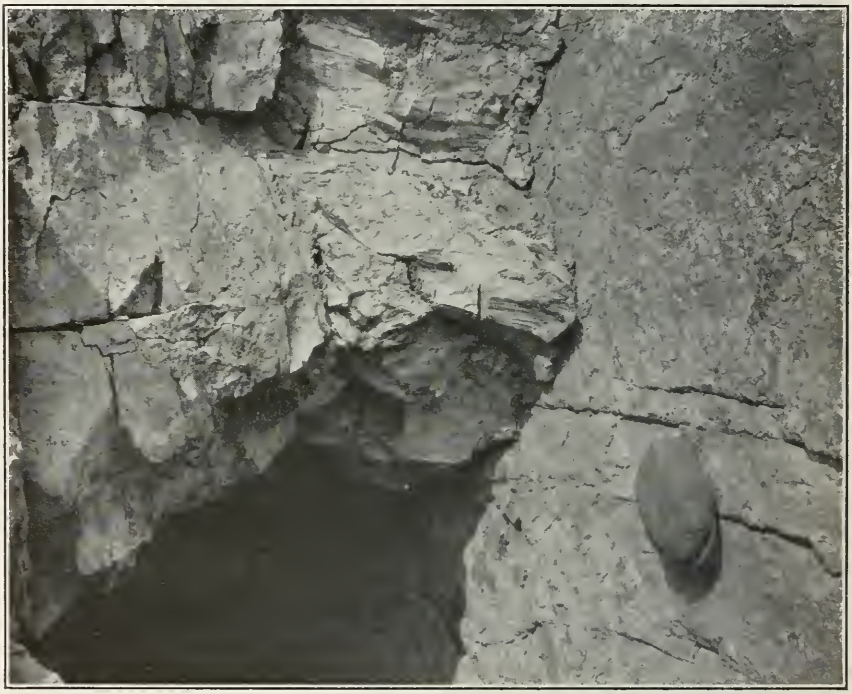


FIG. 5. CRUSHED VEIN OF MAGNESITE, PORTERVILLE, CALIFORNIA.

There is nothing to show that the vein has been tilted from a more upright position to its present place and it was evidently formed as it lies, flat, and cutting across the vertical structure of the serpentine. This is accounted for by supposing that there was a slow movement in the rocks along this plane at the time of the vein's deposition, the magnesite filling uneven open spaces along the horizontal fault, and when there was another movement these depositions would hold the mass apart and make room for contiguous deposits. The crushed condition of the whole mass, and inclusions of serpentine in lines approximately parallel to the sides of the vein, give this hypothesis some color. Other "blanket" veins lie at rather low angles and will probably be found to run into this one. At the north end of the deposits is a stockwork of small veins 2 to 6 inches thick, and it is thought that it may pay to blast the whole mass and hand-pick it.

With the exception of magnesite shipped to the Western Carbonic Acid Gas Company, of San Francisco, for making gas, all of the magnesite mined here is burned before being shipped. Crude oil is used for fuel, and the magnesite is fed into the top of a kiln, gradually rising in temperature until it reaches the flame from the burners. It is then raised to a white heat and kept there for from 20 to 25 minutes when it is withdrawn. Shipments are made from Hilo, a spur on the Southern Pacific Railroad, one mile north of Porterville.

Magnesite is much easier to calcine than limestone, as it gives up all of its CO_2 at 510 degrees C. (950 degrees F.) while limestone demands a heat of 825 degrees C (1,517 degrees F).

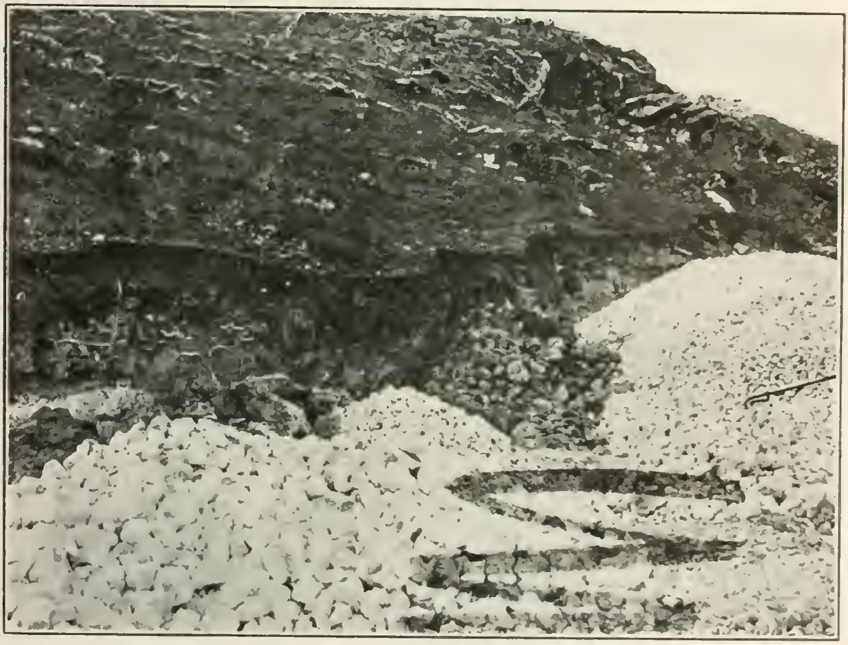


FIG. 6. MAGNESITE AND "BLANKET VEIN" IN FOREGROUND STOCKWORK OF VEINS IN BACKGROUND. PORTERVILLE, CALIFORNIA.

Manufacture of Liquid Carbon Dioxide.

At the time of my visit the Western Carbonic Acid Gas Company of San Francisco, with works across the bay at Sedan, or Emeryville, were the only manufacturers of the gas from magnesite, although one of the subsidiary companies of the American Magnesite Company was erecting a plant at East Oakland (Clinton).

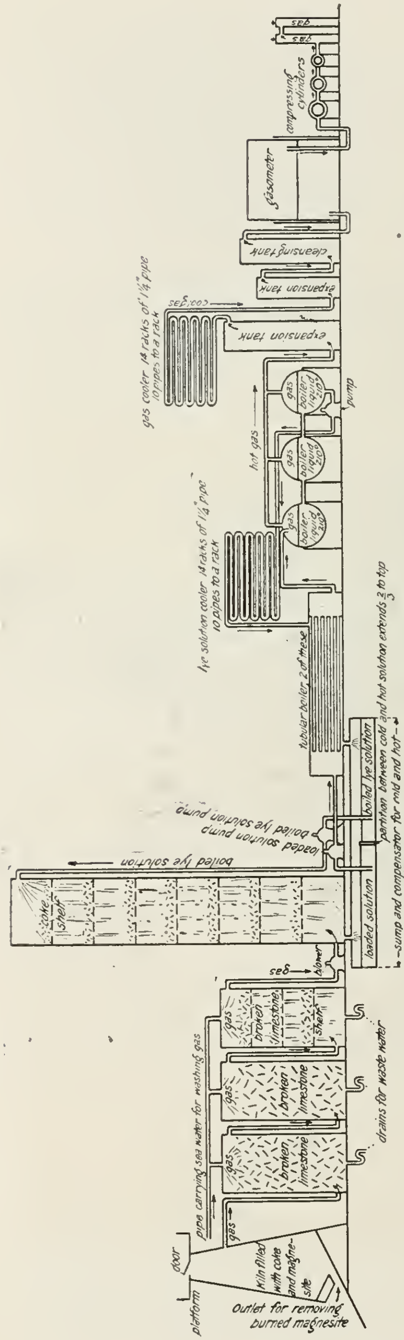
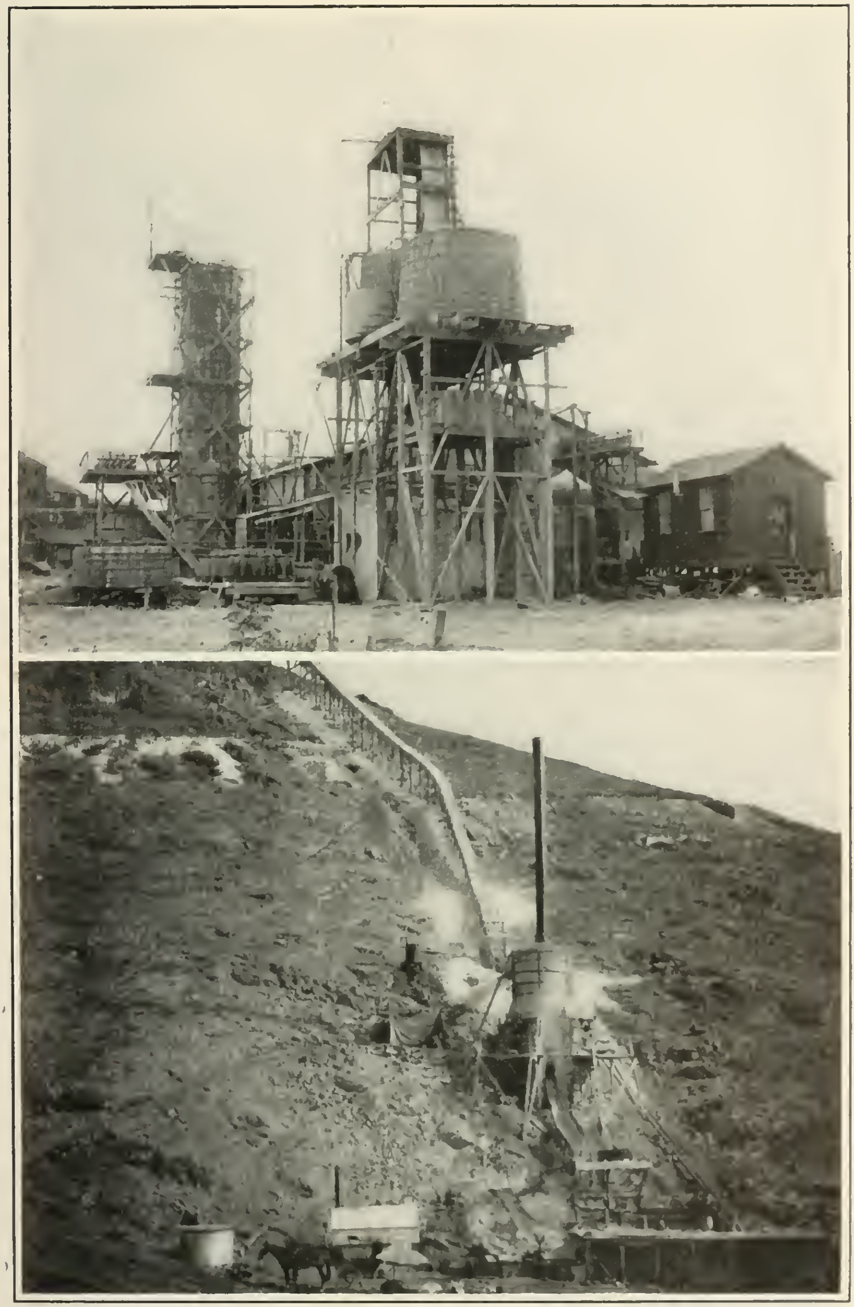

gas
gas
compressing cylinders
gasometer
cleansing tank
expansion tank
expansion tank
CO₂ gas
gas cooler 14 racks of 1¼" pipe 10 pipes to a rack
pump
gas boiler liquid 210°
gas boiler liquid 210°
gas boiler liquid 210°
hot gas
lye solution cooler 14 racks of 1¼" pipe 10 pipes to a rack
tubular boiler 2 of these
boiled lye solution
partition between cold and hot solution extends 2/3 to top
sump and compensator for mid and hot solution.
loaded solution
boiled lye solution pump
loaded solution pump
boiled lye solution
coke shelf
gas
blower
gas broken limestone shelf
gas broken limestone
gas broken limestone
drains for waste water
pipe carrying sea water for washing gas
gas
door
Kiln filled with coke and magnesite
platform
Outlet for removing burned magnesite

FIG. 9. DIAGRAM OF WESTERN CARBONIC ACID GAS COMPANY'S PLANT AT SEDAN, CALIFORNIA.

The magnesite is burned in a kiln with one-tenth its weight of coke, and the gas is pumped into scrubbers, of which there are three, filled with broken limestone to counteract any sulphuric acid formed, and washed with sea water. The gas then passes to an absorption tower where it comes in contact with a sprayed solution of potassium carbonate, by which it is absorbed. The "loaded solution" is then pumped into boilers where it is raised to a temperature just below the boiling point of water. The solution gives up its gas and is pumped back to the absorption tower while the gas is pumped through cleansing tanks to a gasometer. It is then compressed in a three-step compressor to the liquid state and is shipped in steel cylinders holding 25 to 60 pounds. In this process the weight of gas obtained is about 5 per cent. of the weight of the magnesite used. The gas is shipped all over the Pacific Coast and the southwestern States. It is used in refrigeration and in making soda water and other carbonated beverages.

The diagram on this page will probably make the process clear.

This same company is preparing to make light *magnesia alba* by the Pattinson process, to



FIGS. 7 & 8. PLANTS FOR THE TREATING OF MAGNESITE.

The lower picture shows a kiln at the magnesite mine Porterville, Cal.; the upper one shows the plant of the Western Carbonic Acid Gas Co., Sedan, Cal.

be used as an absorbent for nitroglycerine in the manufacture of dynamite. It is said to make a very superior absorbent for the best grades of dynamite.

The following table of analyses will give some ideas of the purity of the magnesite from the different localities described:—

Analyses of Magnesite and Magnesia.

	1.	2.	3.	4.	5.	6.	7.	8.
Silica (SiO_2)	0.10	0.50	1.10	3.30	2.48	*a*1.81	*a*6.68	*a*0.90
Iron Oxide (Fe_2O_3)	.25	.30	.47	7.25	6.02	.08	15.10	.49
Alumina (Al_2O_3)	......	......	.76	.84	1.18			
Lime (CaO)	.62	.70	......	2.48	4.34	Trace	......	1.49
Magnesia (MgO)	47.10	46.90	97.35	84.72	84.56	46.55	37.23	44.39
Carbon dioxide (CO_2)	51.98	51.60	......	......	......	51.25	40.98	50.06
Water and undermined	......	......	.32	1.40	1.33	.32	......	2.57
	100.05	100.00	100.00	99.99	99.91	100.00	99.99	99.90

a Insoluble.

1, 2. Alameda claim, American Magnesite Company, 32 miles southeast of Livermore, Cal.
3, 5. Same, calcined.
6. Chiles Valley.
7. Same, poor; not shipped.
8. Porterville;
Analyst, Nos. 1–5, unknown; 6–8, Abbot A. Hanks, 531 California street, San Francisco, Cal., October 1, 1903.

EXPERIMENTS ON A CONSTANT-PRESSURE GENERATOR.

By C. M. Garland.

The close relation between Mr. Garland's studies and those of Dr. Lucke, preceding in this number, will be at once apparent. The two investigators have been working in separate departments of a single problem — that of the gas turbine — Mr. Garland in the production and Dr. Lucke in the utilization of the fluid medium by which the gas turbine might be driven. The subject is probably the most actively interesting one in the whole field of dynamic engineering at the present moment, and Mr. Garland's results, like Dr. Lucke's, are the outcome of direct, practical, pioneer work.—THE EDITORS.

IN studying the question of the gas turbine, the first and possibly the only practical solution that presents itself is that of a turbine operating on a constant-pressure cycle. Such a turbine may be divided into turbine wheel and pressure generator. As is well-known, this cycle of constant pressure, from a theoretical standpoint, offers a very poor efficiency. However, looking at the question from a practical point of view, certain considerations enter which would seem to make investigation along this line worth while. So, in the fall of 1905, through the aid of the Engineering Experiment Station of the University of Illinois, I was able to design and construct, in the mechanical engineering laboratory of this institution, a small experimental pressure generator of a type presently to be described.

In designing a pressure generator to be used in running a turbine wheel, as suggested above, the question of temperature control is the first to present itself. There are at least two practical methods of controlling this temperature resulting from combustion: One, by mixing a quantity of cool air with the hot products; the other, by allowing the excessive heat of the products of combustion to be absorbed in the generation of steam, the steam being mixed with the products and passing with them to the turbine.

Looking at these two methods of control from the standpoint of high efficiency, it would seem as though the former would offer the best results in this respect. However, there is a certain very serious consideration that must be taken into account, which would seem to render very doubtful the efficient operation of a turbine and generator using this method of temperature control. Especially is this true if the gases are to be conveyed for any distance. This consideration is the low specific heat of air, or of the products of combustion. Owing to this low specific heat, a very small amount of heat lost in radiation, conduction, etc., will represent a very large proportion of the total energy available in the gases, and will consequently lower the efficiency accordingly.

This loss is much greater than is ordinarily supposed, and makes extremely doubtful the efficient use of heated gases outside of the combustion chamber. In the case of the gas engine, the combustion takes place in the cylinder in which the gases are used, with the result that during combustion the cylinder walls, piston head, etc., store away quite an appreciable amount of heat, which is later given out and utilized when the gases begin to cool down through expansion.

In this second method of temperature control, by the generation of steam from the excessive heat of the products of combustion, and the admixture of this steam with the products, the disadvantages caused by the low specific heat are to a large extent overcome. Owing to the high specific heat of the steam, the specific heat of the mixture will be comparatively high. It is also quite likely that the presence of the steam will have a tendency to increase the amount of work done by the mixture as a whole. This will be due to the fact that in adiabatic expansion through any range of pressure, the temperature-drop of gases of low specific heat will be greater than the temperature-drop of the steam through the same range, as shown by the formula

$$\left(\frac{p}{p^1}\right)^{\frac{k-1}{k}} = \frac{T}{T^1}$$

Where $(k-1) \div k = (1.41-1) \div 1.41 = 0.29$ for air and $(1.33-1) \div 1.33 = 0.25$ for superheated steam. The result of this will be that the expansion curve of the mixture will lie above the expansion curve of air or products of combustion, and a greater amount of work will be obtained from the mixture than would have been obtained from the same weight of air expanding under the same condition of pressures, and initial temperature.

With these points in mind, it was decided to construct a generator using the second method of temperature control, and in which the amount of water-heating surface could be varied, with the expectation of obtaining some idea of the correct proportion of steam to products of combustion for the highest efficiency.

The following is a description of the apparatus. Figure 1 is a sketch of the generator with oil and feed-water tanks. Figure 2 is a sketch of the nozzle used for spraying the air and oil. Figure 3 shows a section through one of the tubes. Referring to Figure 1, A is the generator, B the feed-water tank, and C the oil-supply tank. The generator was built up of 12-inch extra heavy pipe fittings, extra heavy in order to withstand any explosions that might occur. 1 is the nozzle by which the amount of air and oil entering the combustion chamber is regulated; 7 the combustion chamber, lined with a mixture of burnt fire-brick, ground and united with fire clay; 6 is the tube sheet into which are expanded the tubes, 8. These are 73 in number, ⅝-inch in diameter and 22 inches long, with .042-inch thickness of metal. The upper ends of these tubes are free. Into the end of each was dropped a ⅜ by 1½-inch bolt, as shown in Figure 3. Directly above the tubes was placed a perforated plate, 9, to prevent the bolts being blown out of the tubes. The object of this arrangement was to prevent the water lying around the tubes, in case of violent ebullition, descending through the tubes into the combustion chamber. The products of combustion pass up through the tubes, mix with the steam, and pass with it out through the valve 20. The valve 20 was in a horizontal position in the generator as constructed, and a thermometer for taking the temperature of the gases was located in an ell between the valve 20 and the generator. 4 is a ¾-inch nipple fitted with an eyepiece 27, for observing the combustion. 17 is a 1½-inch pipe plug. The generator was fitted with gauge glass, pressure gauge, blow-off cock, etc. C is the oil-supply tank, the oil being forced into the combustion chamber by air pressure admitted to C through valve 24. B is the water-supply tank. The water is also forced into the generator through air pressure acting through valve 14. The manner of operating was as follows: Relief valve 25 was opened and water admitted through valve 26. The tank being filled, 25 and 26 were closed and 14 opened. When it was necessary to feed water to the generator, valve 15 was opened.

The manner of operating the generator was as follows: Compressed air at 110-pounds gauge was supplied to nozzle, oil tanks,

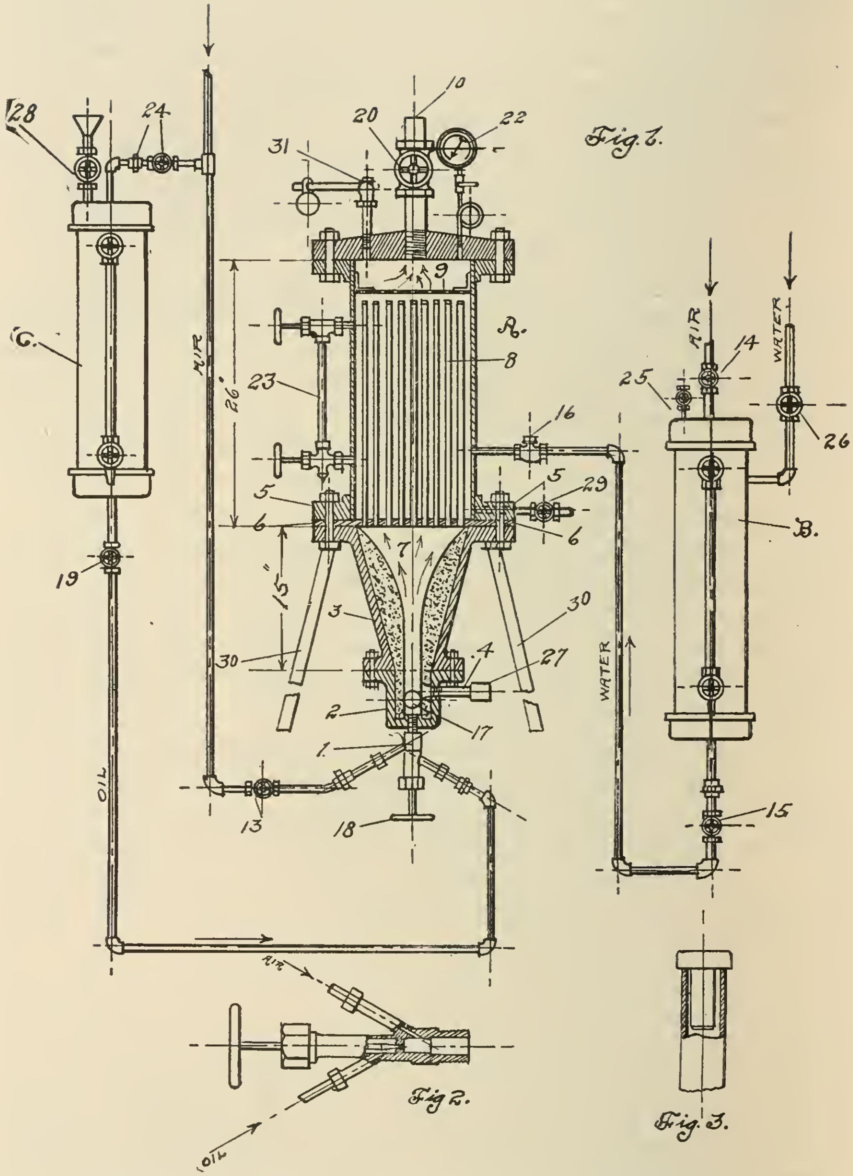


DIAGRAM OF EXPERIMENTAL CONSTANT-PRESSURE GENERATOR.

Fig. 1, Generator, with oil and feed-water tanks; Fig. 2, nozzle used for spraying air and oil; Fig. 3, section through one of the tubes.

and feed-water tank. Kerosene oil was used in all experiments for fuel.

Two methods of starting were tried. The first method was to open valve 20, remove pipe plug 17, pour a small quantity of gasolene into the combustion chamber through opening 17, and ignite by means of a torch. Then slowly turn on the air through nozzle 1 by means of valve 13. After the gasolene had burned for a few seconds, kerosene from tank C was slowly turned on by operating needle valve 18 in nozzle 1, and a bright, steady flame obtained by manipulating this valve (18). It required considerable practice to do this, but after a time it became quite an easy operation. After the flame had continued steady for a few minutes, the pipe plug 17 was replaced by means of a socket wrench, and pressure of 100 pounds gauge was obtained in the generator by throttling down the gases escaping through valve 20. This manner of starting proved to be very satisfactory, more so than the second method, which was as follows. Air pressure of about 60 pounds was maintained in the generator, and a series of sparks started by means of a suitable spark plug, over the mouth of the nozzle, and the oil slowly turned on. In using this method of starting, the burner must be heated up, or else a start with gasolene made by having an auxiliary gasolene reservoir connected with the nozzle. After the chamber is heated up, the gasolene may be turned off and the kerosene turned on. This method of starting would probably be satisfactory if a suitable ignition device were at hand. In the present case an ordinary spark plug was used, and burned out in a short while.

After pressure was obtained in the generator, the combustion was regulated by observing the flame through eyepiece 27, and manipulating valves 13 and 18, until the flame was of a brilliant white. In this way combustion was made very complete. However, it was found that under the best condition possible with this apparatus, a few small particles of carbon would come over in the gases. This was probably due to the large amount of water-heating surface and the short fire-box or combustion chamber. With a combustion chamber properly proportioned, it is believed that this trouble would be completely eliminated. After the generator had been in operation for about thirty minutes, steam would begin to come off and the pressure to rise so that it was necessary to open up gradually the throttle valve 20, in order to prevent the generator pressure rising to that of the compressed-air supply.

The points to be determined in constructing this apparatus and carrying on the experiments, were:—

First, to determine if this form of generator were practical, and if so what obstacle would have to be overcome in placing such a generator in commercial form.

Second, to determine if possible what efficiencies might be expected from a plant using this form of generator.

As to the first question, so far as the practical operation of such a generator is concerned, within the range of pressure and temperature used, no serious difficulties have to my mind presented themselves. There were a number of troubles encountered, such as sputtering of the flame on starting, incomplete combustion, melting out of the fire-brick lining, etc., all due principally to incorrect proportion of parts. After the generator was once heated up, and the supply of air and oil regulated, there were no other troubles. The combustion seemed to be, and evidently was, much more intense under pressure than it would have been at atmospheric pressure. The higher the pressure the more intense the combustion, and possibly the more efficient. The temperature reached in the combustion chamber must have been very great, as the fire-brick lining, after a two-hours' run, melted out and covered the mouth of the nozzle to a depth of three or four inches. Owing to this difficulty the experiments were brought to a temporary close until a different form of combustion chamber could be constructed.

The highest temperature reached by the gases above the tubes was 600 degrees F. The temperature of the gases seemed to vary considerably, all the way from 450 degrees F. to 600. This low temperature was due to the large amount of water-heating surface and the small diameter of the tubes. The question of temperature regulation is one that at the present time need not be considered, as the amount of water-heating surface will tend to keep the temperature constant, and within reasonable limits.

The pressure used, as above stated, was about 100-pounds gauge in the generator. The pressure of the compressed-air supply was 110 pounds. The regulation of the pressure was found to be a comparatively easy matter, and no doubt could be made automatic for varying loads. The reason for this belief is, that after a certain proportion of air and oil is reached, necessary for complete combustion, a still greater quantity of air, seemingly, will not affect the combustion; it is therefore evidently unnecessary to regulate the air with any great degree of accuracy, it being sufficient always to keep the amount of air at or above that quantity necessary for complete combustion. This statement has been found to be practically true in the case of the generator under consideration. After the proper proportion of air and oil necessary for complete combustion was reached, a still greater quantity of air could be admitted without producing any other effect than a slight lowering of the temperature of the gases.

The second question to be determined was that of efficiency. Two generator tests of one and one-half hours each were attempted, and one engine test. Owing to the linings melting out and causing trouble with the nozzle, no accurate results were obtained. Such as they were, however, they indicated a very high efficiency considering the size of the apparatus, and served as a stimulus to further investigation. At the present time a new combustion chamber is being constructed, and as soon as it is completed, experiments will be resumed, with the object of determining some idea of the efficiency, the proper proportion of steam and products of combustion, and the form of turbine best adapted to be used with this type of generator.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

VII. SPEEDS AND FEEDS.

With this article Mr. Becker closes for the present his study and discussion of the introduction, treatment, and use of alloy-steel tools. His series began in THE ENGINEERING MAGAZINE for September, 1905, and extended at that time to a group of four articles, taking up successively the general outlines of the problem, controlling principles in introducing the steel into the shop, working directions for making and treating tools, and the design and operation of tools and machines. In the supplementary series now concluded he has considered the range of adaptability of alloy-steel tools, the "Tool at Work", and now the extremely important question of speeds and feeds.—THE EDITORS.

THE conditions under which metal-cutting tools work are so various that it may well be doubted if any generalizations could be made with respect to feeds and speeds which would be applicable in any considerable number of given cases. Some conditions are undoubtedly fundamental—the inter-relation of feed and speed, for instance; but most of the other elements vary so much that there is likely to be confusion and uncertainty in the application of formulas to specific jobs. The very fact of such a multitude of conditions and variants, however, makes it necessary, in a discussion of this subject, to bring out of the great mass of individual experiences some sort of generalizations which may be useful as guide marks or criteria, to which certain classes of jobs may be referred with the expectation of realizing a reasonable degree of efficiency; the conditions being later modified as experience may indicate. The mere recital of experimental results serves small purpose outside of showing, perhaps, the possibilities under given circumstances. Thus there is little significance in the statement that a certain tool cut soft steel in a lathe at the rate of two hundred feet a minute. But if it can be shown that under a given set of conditions susceptible of approximate duplication in a pretty well defined group of jobs, a tool can be expected to do a certain amount of work, something is gained which may be used as a basis of comparison for all jobs falling within the classification so defined. It is the purpose in the present discussion to develop such classifications, very elastic and only approximate of course, but found by experience to serve this purpose.

Four elements have been previously mentioned as fundamentally affecting the efficiency of a tool, namely, first cost, accuracy of work, cost of maintenance in an efficient state, and endurance. There are of course many other factors, more or less incidental and dependent upon the conditions involved. Obviously the endurance of a tool, or in other words, the total amount of work it is capable of doing, is the most important single test of its efficiency.

Now the amount of work done by tools of the kind under consideration is simply the quantity of metal removed in a specified time, whether that be the whole life period of the tool or a shorter time. The problem then becomes one of how much of a cut can be taken continuously, and at what speed. The problem in this form ignores such factors as the strength and powering of the machine in which the tool is used. For the purposes of this discussion these elements need not be considered, since it is assumed that the tool is to work in a machine capable of driving it at its highest efficiency. Working under less favorable conditions merely involves a reduction in efficiency corresponding with the reduced capabilities of the machine.

The amount of metal that can be removed in a given time is limited also, in the case of high-speed cutting tools, by the combined capacity of the tool, the chip, and the piece being tooled, for carrying away the heat generated in the cutting. These tools, as already stated, not only work well when hot, but even require a preliminary warming up before they can do their best work. Nevertheless the heating cannot go too far, without injury, and it is necessary to make the conditions such that the heat can be conducted away so that the cutting edge does not reach a temperature high enough to show any red color. It is true that some tools have been found to work well even when showing some red; but in general it is not safe to work a tool to this extent. At such a temperature the critical point, at which the edge begins to crumble more or less, is not far away.

Now the chief factors that affect the generation of heat at the cutting edge are the size and shape of the tool, size and shape of the chip, speed at which the cut is taken, toughness or hardness of the material, and method of lubrication or cooling agent, or lack of it. In the case of cylindrical cutting the diameter may also become a factor. Whence the endurance, that is to say, the efficiency, of the tool depends upon a proper adjustment or balancing of the factors just named. Where the machine itself is relatively inefficient, there is of course a further adjustment to be made, compensating for this. The relation of these factors is easily seen in the formula

$$\frac{S \times F \times D \times H}{T + L + C}$$

in which S, F, D, H, T, L, and C represent respectively the speed, feed, depth of cut, hardness or toughness of the material and chip, conductivity of tool, lubrication, and conductivity of the material and chip. It is possible to classify jobs in such a way that for each class the last four of these elements become approximately fixed, leaving only the cutting speed, feed, and depth of cut to be determined. These are likely also to be somewhat affected by the diameter of the finished piece, as already pointed out.

In the manufacturing shop (as distinguished from the engineering shop)—that is, in the shop wherein pieces are reduplicated in large numbers—even the depth of cut becomes a constant for practically all kinds of jobs upon similar materials. Thus, as shown in the previous article, gray-iron castings should be over-sized enough to allow for a cut of about $\frac{1}{16}$ inch in depth, except in the case of pieces of unusual shape, easily warped or susceptible of bad coring, when a greater allowance should be made. So also with other materials, for the most part; the depth of cut is regulated by the size of the material selected, and can be made practically constant outside of the relatively few exceptional cases. In the engineering or tool-making shops, however, there is certain to be much variety in the amount of material to be removed, so that this continues to be a variable.

Let us see how the problem works out in the case of gray-iron turning.

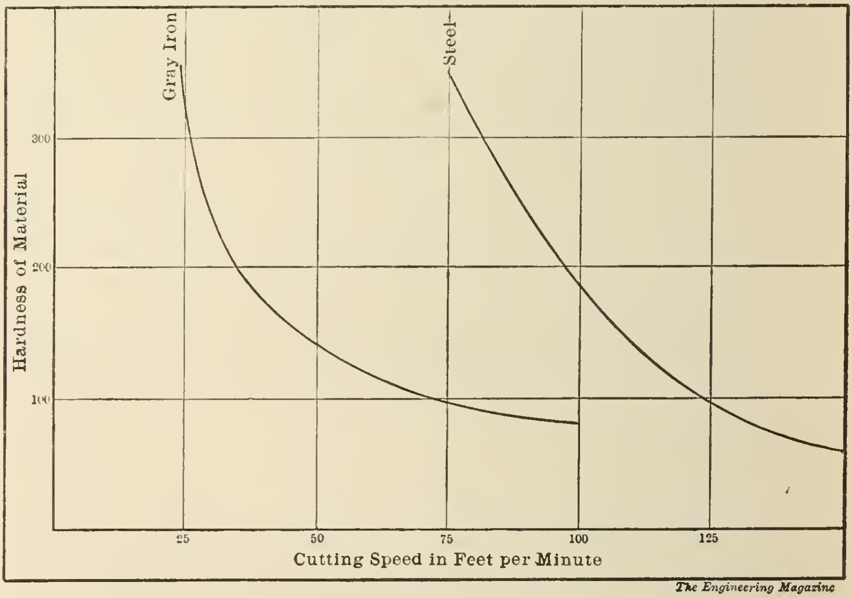
Starting with the depth of cut indicated, $\frac{1}{16}$ inch; omitting, as usual in gray-iron working, a cooling agent; assuming the tool to have been shaped and sized so that the conductivity of tool and chip may be disregarded; and taking metal of average or medium hardness, the only factors remaining to be determined are the feed and speed. These vary (all other elements, such as size and shape of tool, for instance, remaining constant) inversely with each other; so that any increase in one implies a decrease in the other.

There are certain limitations in respect to feed that permit comparatively little latitude. With tools of the ordinary shapes it is obvious that a heavy feed produces a rough finish; and since most work of the sort now under consideration must be done with a single cut, it is necessary to select a feed that will leave a satisfactory surface. Anywhere from 1/16 to 1/8-inch feed will do this, the exact amount being easily ascertained in practice. Theoretically a variation so great as this would seriously affect the possible cutting speed. Practically, however, it is of little consequence. If the tool were being regularly speeded to its limit, of course such doubling of the feed would at once affect the life of the tool (that is to say, of a grinding) and necessitate a corresponding decrease in the speed; but in practice the speeds used are far under the highest limits, chiefly for the reason that the tools are rarely used in machines capable of working them to their maximum capabilities, and that it is often inconvenient to handle materials fast enough to keep up with the tool. At the speeds found most practicable under present conditions, a change of 1/16, say, in feed, does not affect the number of grindings sufficiently to be noticeable. Under the conditions given it is shown very conclusively in laboratory experiments and tests, as well as practical shop experience, that for work of moderately small diameters (say up to 5 inches) a speed of 65 feet per minute is as great as can be continuously maintained without too frequent grinding of the tool. On work of larger diameter the speed can be increased 10 to 15 per cent, because the direction of the cut is not changing so quickly and the chip therefore does not need breaking up or curling so rapidly. Furthermore, in gray-iron castings the smaller pieces commonly chill more or less even in sand molds, and the light cut required scarcely does more than remove this skin of chilled iron—which is of course much harder on a tool than a deeper cut would be. In large parts there is little or no appreciable chilling of this sort, and the material cuts with correspondingly greater ease. In all cases also where the skin of scale and hard iron has been removed, a considerable increase in speed is attainable. Thus in experimenting in turning operations upon a large drum, after the first skin cut a speed of 125 feet per minute was maintained as long as it was interesting to observe it, without damage to the tool. Such a speed is often attained in tests under more trying conditions, but in actual practice is rarely as efficient as the slower speeds indicated.

As for work requiring heavier cuts, say up to 1/2-inch depth, allowing a feed of about 1/8 inch, a speed of 45 to 50 feet per minute can be maintained without trouble. Such cuts would obviously be taken on pieces of relatively large size only, say 6 inches diameter, and over. Under exceptional conditions 90 feet per minute have been maintained for long periods of time.

Extra hard gray iron can be turned at 25 to 35 feet per minute, as shown in the curves (Figures 1 and 2). Chilled iron may be finished at anywhere between 3 and 12 feet per minute. It is really of small consequence anyway, because most of the time in this kind of work is used in changing the tool and sharpening it. A tool that will hold up at 3 feet per minute will also hold up at 12 or even more.

Obviously there will be variations in speeds corresponding to variations in feed and depth of cut between the largest and smallest section of chip specified in the above. The curves in Figures 1 and 2 are useful for determining the speed practicable in most cases, not only in machining gray-iron castings, but also the other materials named.



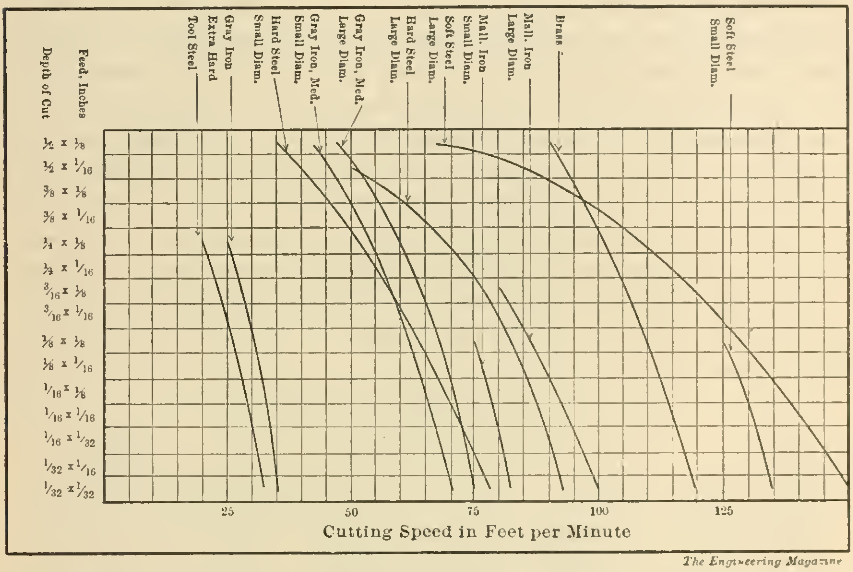
The Engineering Magazine

FIG. 1. CURVES SHOWING THE EFFECT OF INCREASING HARDNESS IN MATERIAL UPON THE SPEED PERMISSIBLE TO A TOOL, FOR EFFICIENT SERVICE.

100 is taken as the standard for moderately soft material, and 400 as about the limit of hardness as usually handled in manufacturing.

On steel speeds as high as 247 feet per minute (cut ¼ by ⅛) have been attained for short times—and this on 0.4 per cent steel. On such steel, however, 100 feet is all that can be desired for continuous performance, and 75 to 85 feet is in practice very satisfactory. In one instance 0.6 per cent steel is turned at a speed of 72 feet, feed 1/32, cut

⅜, diameter of shaft 2 inches; but so far as reported nobody else is able to do the same thing continuously—for the reason probably that in this case the job is done under exceptional conditions as to lathe, shape of tool, etc. Ordinarily 50 feet is very good speed for a job of this sort.



The Engineering Magazine

FIG. 2. SPEEDS SUITABLE FOR VARIOUS FEEDS AND DEPTHS OF CUT, IN TURNING OPERATIONS.

For milling operations add 50 per cent to the appropriate speeds indicated above, taking care to apply the selected speeds to feeds for which they are suited. For boring subtract 10 to 40 per cent and for drilling and reaming, see table of drill speeds and feeds on the following page. The "small diameters" refer to those under 5 inches.

Low-carbon and machinery steel can be turned (in large diameters and with light feed and cut) as fast as 150 feet per minute, and sometimes even faster. In heavy cutting, say ⅜ to ½-inch depth by ⅛-inch feed, 65 to 70 feet is all that can be recommended ordinarily.

In malleables, 80 feet is about all that can be expected on small work. This of course is practicable only in the case of light feeds and cuts, which are the only kind that should be taken on parts of this material, for reasons already given. On larger pieces the speed may reach somewhat above 90 feet, and under exceptional conditions, 100.

Speeds for brass and the other soft metals, as may be seen, are considerably greater than for soft steel. The highest speeds given for soft steel usually are much too great for bronzes, however, which curiously enough allow a speed scarcely ⅔ as great as that for soft steel.

It has doubtless been observed that the speeds and feeds thus far indicated are those suitable in turning operations. Except only in milling, where the teeth of the tool cut intermittently and have plenty of time to cool off, turning operations permit greater speed than any others involving the cutting of metals. It is necessary therefore to make suitable allowances in the case of other operations. Internal cutting with a boring bar, for instance, must be considerably slower than external turning of the same diameter. In regular turning the tool has ample clearance and can ride more or less on the finished surface, whereas in the case of internal cutting this is impossible. And furthermore, in order to obtain the requisite clearance from the concave finish, the point of the tool is necessarily more acute or else has less rake than is allowed by external work. Either condition involves a loss of efficiency, and therefore necessitates reduced speed. From 10 to 15 per cent reduction in speed as compared with external work may be expected, with a very rigid bar—otherwise the loss is more likely to reach 40 per cent.

SPEEDS AND FEEDS FOR DRILLS.

Size of Drill.	REVOLUTIONS PER MINUTE.					Feed per Revolution.
	Steel.	Mall.	Cast.	Brass.	Tool Steel	
1/16	4015	4620	4820	7650	1970	.001–.002
1/8	1850	1925	2220	3515	906	.002–.004
3/16	1380	1610	1650	2810	675	.003–.006
1/4	1040	1190	1250	1970	506	.004–.008
5/16	855	982	1028	1620	420	.004–.008
3/8	782	806	836	1330	342	.005–.010
7/16	604	688	720	1140	295	.005–.010
1/2	527	605	632	1003	258	.008–.016
5/8	425	488	512	807	210	.008–.016
3/4	347	410	420	666	173	.008–.016
7/8	300	346	360	568	146	.008–.016
1	260	298	312	495	128	.010–.020
1 1/8	228	264	276	436	112	.010–.020
1 1/4	215	248	260	410	106	.010–.020
1 3/8	200	230	238	380	98	.010–.020
1 1/2	178	205	216	342	92	.010–.020
1 3/4	154	173	180	290	73	.010–.020
2	130	150	156	246	64	.010–.020

These speeds involve peripheral speeds of 60 to 65 feet per minute, in soft steel. For reamers, only about half the above speeds are permissible. The feed per lip is preferably the lighter one given in any particular size. For taps and dies about the same speeds may be used as for reamers.

Much the same is true in the case of rose reamers, and to some extent of twist drills, although in practice it is unnecessary to take this into account—chiefly for the reason that there is scarcely a machine built (if indeed there be one at all) that will speed a drill of this sort to its limit. The most satisfactory practice in drilling gray iron allows a peripheral speed of about 65 to 70 feet per minute and a feed of .008 to .020 inch per revolution, in the sizes of ½ inch and above. This is somewhat faster than the common practice, but gives good results.

Twist drills have ample rake at the cutting lips and therefore can run much faster than reamers, in which latter the chip butts squarely against the front side of the cutter and thus imposes a heavier duty. The speeds given in the table herewith have been found to be good practice in a great variety of materials and conditions. An examination of the table will show that the peripheral speed of small drills is slightly greater, in general, than that of larger ones. This is found to give greater efficiencies than were obtainable with the method of allowing uniform peripheral speeds. Inasmuch, however, as most drilling jobs, especially the small diameters, are done on hand-feed presses and machines, in which the feed is merely a matter of the operator's judgment, or more likely of his strength of arm, the question of feed is of small moment for the great majority of jobs of this character. On jobs where a forced feed is used, of course it can be regulated to conform to good practice, as shown in the table.

Reamers can safely be run at speeds about half those named in the table for the several diameters. In this case, however, forced feeds are much more commonly used, and always in the larger diameters, so that the matter of feeds becomes of consequence. In using the table it is to be remembered that the feed given is for two-lipped drills; whence the formula for deriving the proper feed is

$$\frac{F \times L}{2},$$

where F and L are the stated feed and the number of cutting lips respectively. This gives, for a 2-inch six-fluted reamer, a speed (in gray iron) of 78 revolutions per minute and a feed of .3 inch per revolution. It is not safe to use with reamers the heavier feeds specified for drills, the lighter feed being the most satisfactory.

The highest practicable speeds attainable in metal cutting are reached in milling operations. The reason plainly is that the individual cutting edges work during a small fractional part of the time required for a revolution, the remaining time serving to cool them; and since one of the chief elements in the efficiency of a tool is the ability to keep the temperature below the critical point, this circumstance gives milling cutters a great advantage. Indeed, as compared with lathe tools, the advantage—that is to say, the practicable increase in speed at the cutting point—is something like 50 per cent. Obviously, also, the larger the diameter of the cutter (within limits) the greater the allowable speed, and therefore the greater the proportionate advantage. Generally, however, this may be disregarded.

The peripheral speed allowable to a properly proportioned milling cutter is therefore (on medium gray iron) about 90 feet per minute, with a depth of cut amounting to ⅛ inch and a feed of .01 inch per cutting tooth. Anything heavier than .01 is allowable of course only on cutters of moderately large size having teeth with plenty of clearance. Higher speeds than that given are sometimes used, but rarely with good results. In fact, it is generally better to use a speed somewhat lower and to take a rather heavier cut.

With the basis given, the speed and table feed for any milling tool may easily be worked out. The number of revolutions follows from $90 \div C$, in which C equals the circumference of the cutter in feet, and 90 the accepted cutting speed, also in feet. The table feed is derived from the formula $T = N \times R \times F$, where T is the table feed, N the number of teeth, R the revolutions per minute, and F the allowable feed per cutting tooth, which may be about .01, as already stated. Taking a miller of say 9 inches diameter and with 30 teeth, we have the following:

$$C = \frac{9 \times 3.1416}{12} = 2.3637 \text{ feet;}$$

and R (number of revolutions per minute) $= 90 \div 2.3637 = 38$.

Also, T (table feed per minute) $= 30 \times 38 \times .01 = 11.4$ inches—which is more than most machines will stand. In such case, of course, either speed or feed may be reduced, as the nature of the job may suggest.

It should be said here that the amount of feed is to be regulated largely by the kind of surface required. A milling cutter will generally stand all the feed the machine will pull; but coarse feeds make rough surfaces, and the table feed is therefore limited by the requirements as to accuracy and smoothness of the finished surface.

Of course, as in the case of other tools, allowance has to be made for the kind of material, in fixing a practicable peripheral speed. Those found most generally efficient are: gray iron, 90 feet per minute; malleable, 86; steel (soft), 75; tool steel, 37; and brass, 140. This is for a table feed of .01 inch per tooth per revolution, or less; and a depth of cut not much exceeding ⅛ inch.

It does not seem worth while to give a table of speeds for milling cutters, since the conditions vary so greatly. By the use of the basic speeds for the various materials as just given, in connection with the formula used above in the illustration of the case as applied to gray-iron castings, there should be no difficulty in determining the speeds suitable in particular cases.

As to planer and shaper work, it is perhaps necessary only to point out that the tools will do anything the machine may be capable of. The few new machines of this type that undertake to give the high-speed tool a chance allow a maximum of about 50 feet per minute on steel. Older types of machine cannot get much more than half this without much burning up of belts and a great deal of racking in reversing.

Taps and dies may be run as fast as the material can be taken care of; which, with ordinary thread pitches, will give peripheral speeds approximately half that given in the table of drill speeds. For some of the materials used even this must be greatly reduced, for the reason already given.

In conclusion it may be pointed out (though it is perhaps so obvious as scarcely to need it) that the last word has not yet been said as to speeds and feeds for alloy-steel tools. The wonderful capabilities of high-speed steel, as shown in experimental tests and also in many instances of practical shop work, indicate very clearly that the relatively ordinary work to which present practice puts them, is not of the order that counts for highest efficiency in the metal industries; and that in time there must come improvements in machinery and methods such as will permit these new tools to work regularly and continuously to their utmost capacity. Anything less than this is industrial waste, and cannot be permanent.

SOME PRIMARY CONSIDERATIONS IN THE DESIGNING OF POWER PLANTS.

By A. E. Dixon.

Mr. Dixon's article is introductory to a series which will cover broadly every important phase of the physical and mechanical aspects of the power station. It will be recognized at once as the work of a man who is "on the inside," familiar not merely with plans and projects, but with their practical execution. He deals with the utmost frankness with every question, as it has appeared in his own experience, whether it concerns the architect, the contractor, the engineer, the manufacturer, or the owner.

The September section, which begins the main discussion, will take up the location of the plant, and the storage, handling, and general care of the fuel.—THE EDITORS.

THE generation of power for various purposes is of considerable economic importance, and the field of the power-plant designer is a wide one. There are power plants and power plants, from the rough board shack from which steam or compressed air is distributed to the machinery on a construction job, to the rather ornate structure where the electric power for the operation of the New York Subway is generated, and between these latitudes there is much opportunity for choice. Necessarily, there is a difference between (so-called) temporary and permanent plants; the terms are but relative, for owing to the continual improvements taking place in the machinery for this purpose, it is often a money-saving operation to displace machinery, long before it is worn out, by that which will be more economical in operation. In many cases the units installed for service in plants which are to be removed as soon as the purpose for which they are installed is completed, are as large as and even larger than those used in permanent plants—that is, plants which are permanently located. The main difference between the permanent and the temporary plant lies, usually, in the structure housing it and the conveniences installed. The necessities of the case require a building of sufficient stability only to support, shelter, and protect the machinery and those who operate it, and of a durability sufficient for the purpose to be served.

An ornamental building will not increase the operating efficiency of the machinery, while it will increase the fixed charges; but at the same time it is highly desirable, from an ethical point of view, that the shell encasing a power plant should not be the phenomenally ugly red-brick excrescence it so often is. To a certain extent it is desirable that the building and its immediate surroundings should present a pleasing appearance, and there is no doubt that such surroundings have a certain effect on the *morale* of the operating force which conduces to the operating efficiency of the plant.

The ultimate and only end of a power plant is to deliver power, in quantities to suit, to the transmission lines, at the lowest attainable gross unit cost, and the building with its contained machinery is but a completed machine for this purpose. The building is erected only for the utilitarian purpose of supporting and protecting the equipment, in such a manner that it may be operated with due economy, and everything must be subordinated to those purposes. The steel frame and the architectural features of the building must be adapted to the mechanical equipment. There are a number of extensive power plants in operation which present evidences of a lack of co-ordination between the engineering, architectural, and structural forces engaged on the work—the *prima facie* evidence being, in some cases, the use of cross or X bracing in places where its use should not be permitted under any circumstances, and more often appearing in an exceedingly ugly, but very necessary, addition to handle the fuel supply and the outgoing refuse. From necessity, most power plants are located on the water front, and to the general public, which rarely sees the plant except from passing boats, the most conspicuous architectural feature of the plant is the corrugated-iron shed over the coal-handling plant. One effect of the blocking up of the fairways with X bracing is an increase in operating expenses, due to the fact that the men cannot get around to advantage, and this may be sufficient to make such misplaced material a most expensive investment; in addition, it adds to the hazard of the operating force in the line of possible death traps should any one be so unfortunate as to be caught in these restricted passages when a pipe breaks. Unfortunately those who are responsible for such conditions do not realize the danger or the extra operating expense due to such structures.

One of the causes leading to such results is the attempt to divide the work on hard and fast lines and to farm it out among several semi-independent departments; necessarily each department is working entirely for its own record, and the resulting assemblage is fearfully and wonderfully made.

The entire work, mechanical, electrical, structural and architectural, is so closely inter-related and overlaps at so many points, that for economic reasons it is absolutely necessary to place all the work, both in the office and in the field, entirely under one responsible head. Unless this method is followed, a great deal of absolutely unnecessary expense will be incurred; the contractors for different portions of the work, being responsible to different authorities, will be difficult to control; gaps will be found, where contractors do not meet each other, and overlaps, where the same piece of work will be assigned to two or more contractors, the result being more or less confusion and bad feeling between the various departments. This last, while not likely to be openly displayed, will be to an extent a retarding force, holding back the work, often to a troublesome extent, and producing friction between the different contractors. It will be almost impossible to map out the work and conduct it in a harmonious manner, and the responsibility for delays will be difficult to fix, each department endeavoring to pass it on to some of the others.

The contractor first on the ground will preempt all the available space, and later arrivals will find their access to the work so badly blocked that they are put to extra and unconsidered expenses in the handling of their material; this will cause dissatisfaction and make it difficult to secure that mutual accommodation between the several contractors which is essential to rapid progress. The adjustment of difficulties between different contractors will be troublesome, owing to the fact that the departments concerned will endeavor to favor as much as possible the concern handling their particular work.

Another cause of trouble, in many engineering projects, is due to the human frailty that there must be something more than drawings to show at the outset. In spite of the oft-repeated proverb that "haste makes waste," contracts are let from incomplete drawings and on specifications drawn up from them, stating that the privilege of making alterations is reserved and that further detail drawings will be supplied as necessary; unit-price figures are asked for, so that such changes may be made on a fair (?) basis, the portions of the work omitted from the drawing being usually the most difficult and expensive part to execute, and a part which it is impossible to detail until the project has been worked out more fully. For the contractor this sort of a programme may mean a large financial loss and perhaps bankruptcy, for the reason that his only remedy for such jug-handled agreements lies in a suit at law, which puts him to a great deal of expense and makes him wait a long time for a final decision and settlement. On the other side, while the contract costs may look low, by the time all of the law suits are settled and the bills for legal expenses paid, it will be found that such contracts are expensive to handle. In many cases the contractor will rush the work ahead with the idea of forestalling any changes, and as a result of his speed it will be found that the desired alteration involves the tearing out of completed work; or in many other cases it happens that fabricated materials must be taken over at the contract price, and altered as an "extra," at an additional price, or disposed of at a loss. It rarely pays to make an exceedingly strenuous start on a project of this kind, the time to rush matters being just as soon as all the details are definitely settled and there is no uncertainty in regard to the future of that portion of the work.

The man in charge of the construction of a large power plant must be posted, to a degree, in all the various lines of work involved, and should be permitted to avail himself of the services of competent consulting engineers—specialists in such lines as he may deem desirable—for advice and assistance. In the selection of a consulting engineer for any piece of work, it is of the highest importance that he should be disinterested. It is extremely difficult to serve two masters with strict impartiality; most men's sympathies are with their own pockets, and their judgment is liable to be badly warped by the conflicting elements involved, particularly in those cases in which the consulting engineer happens to be the sponsor of some particular method of dealing with the problem or some of its details, from which method he either directly or indirectly receives a royalty or profits.

All the drawings, particularly those to be used for field construction, should be prepared in one office; nothing should be left to chance; the meeting points of all contracts should be accurately laid out and so clearly shown that no opening for verbal arguments on the question remains. This involves a large amount of detail in many of the lines involved. For the building and foundations, in some portions of the work, regular architectural procedure can be followed—that is, the details can be made to approved drawings submitted by the contractor; but it must be distinctly understood that the approval of drawings does not in any way relieve the contractor from any responsibility in regard to their accuracy. In supplying one contractor with copies of drawings made by another contractor, the contractor supplying the drawings must be held strictly accountable for their accuracy, and this fact should be distinctly stated each and every time such blue prints are sent out.

In other portions of the work it is impracticable to leave the design to the contractor. The entire structure is simply a completed machine, and many portions of the interior must be arranged to exact dimensions and lines; for this purpose the drawings usually turned out in architectural offices are often worse than useless, unless the proper dream book and trance medium are available for their interpretation. This is due to the fact that a great deal is left to the imagination, and that few architects care to be hampered by exact dimensions.

In the case of large plants it is advisable to insist that the tracings of all approved and detail drawings from which the various machines, equipment, building, etc., are constructed or manufactured, shall become the property of and be delivered to the concern owning the plant. In any case the contractors should be required by the terms of their agreements to supply from five to twenty prints of all approved and detail drawings covering their respective portions of the work. Precautions of this kind may seem excessive, but there are many cases where if attention had been paid to this apparently trivial point the operating company would have been saved a great deal of expense. Many concerns have objections to supplying information of this kind to their customers, forgetting, apparently, that the customer can easily take the machine down and secure all needful measurements to duplicate the drawings, although such procedure is of course expensive. To guard against trouble in the matter it is advisable to provide in the specifications and contract for the delivery of such prints and tracings, and no vouchers should be approved for payment until the appropriate drawings have been delivered. The importance of this provision arises from the fact that many firms have such poor records of their past work that their efforts to supply extra and repair parts are productive of much trouble to those so unfortunate as to have their apparatus in use. In other cases firms fail or go out of business in other ways, and it is difficult, if not impossible, to trace up their drawings after the lapse of years. In a power plant continuity of operation is of the highest importance, and it is a great deal easier and cheaper to look out for such things at the beginning than it will be later on. In many cases the constructing force seems to be pervaded with the idea that a great many things are of small moment, provided they affect the operating conditions only, seemingly forgetting that the future of the plant, which is out of their control, affects in a measure their own future.

In some cases, power-plant projects, and other engineering work, are handled as one contract by a firm of contracting engineers. There are three methods available for letting the work; on a lump-sum price, which is not conducive to the best results; on cost plus a lump sum, or on cost plus a percentage. The former of the last two methods has advantages when the project is not of sufficient magnitude to justify the organization of a suitable engineering force; the second method likewise has its merits in this regard, but in such cases (except, of course, with contractors of the best standing) there may be some tendency to work in more expensive apparatus than is desirable, in an endeavor to swell the fee received. In case any of these methods is adopted, the best interests of the purchaser will be served by the retaining of an independent consulting engineer, skilled in this line, to advise in regard to the approval of the plans, contracts, and other items. It is to the credit of many of these firms of contracting engineers that they do not handle contracts except on a basis that as nearly as possible renders their interests identical with that of their customers, and while, under the cost-plus-a-fixed-sum contract, the customer has absolute control of affairs, he, unless guided by an absolutely disinterested expert, will be more or less at the mercy of the contractor.

There are a few firms which, besides engaging in the contracting-engineer's capacity, likewise undertake to finance the undertaking, and in many cases also engage in the promotion of enterprises; and there are many projects which, but for the assistance of such many-sided firms, would die in the embryo. The profit to such firms is based on the risk incurred, but as their co-operation often insures the success of undertakings, owing to their being able to supply experienced managers of much greater skill than the enterprise under other conditions could command, in its early stages, there are advantages to be gained by such an alliance, even though it increases the ultimate cost of the installation. High finance, however, rarely results to the advantage of the early stockholders.

There is a time-worn saying, "Look out for the pennies and the pounds will look out for themselves;" for engineering work this can be paraphrased: look out for small details and keep your eye on the large ones.

CHINESE LABOR IN THE LIGHT OF MODERN INDUSTRY.

By Barrett Smith.

The problem of getting sufficient workmen is one which is pressing heavily upon some of the world's greatest engineering undertakings—as for example the mines of the Rand and the Panama Canal—and hopeful eyes have been turned to China to supply the need. It is well worth noting that those who know the Chinese coolie best are generally strongest in his praise. Mr. Smith's testimony is doubly valuable—first because it has been gained personally, in a wide range of work directly connected with engineering industries; and second because it covers not only ordinary labor, but that which in any part of the world would class as skilled.—THE EDITORS.

THE growing importance of China in the trade relations of the world very naturally draws the attention of those interested in the general problem of labor to the Chinese workman, on the score of his fitness to meet the demand of modern industrial conditions. An accurate conception of the problem is impossible, nor may a satisfactory answer be anticipated, save through study of Chinese of the artisan and coolie classes at work in China. The variety of race and the variety of caste found in the large industrial establishments in the Empire could certainly not be duplicated anywhere outside. The racial variation is always at first a surprising feature, and the dissimiliarity of physique and of temperament between the representatives from the two great halves of China roughly divided by the Yang-tse River is very marked, especially near the coast.

Whatever the use made of them, the opportunities for sizing up the Chinese workmen in their own country are certainly ample, for there are now in the coast provinces many large engineering works and general industrial establishments dependent for successful operation, always in part and often indeed wholly, upon Chinese operatives. Further, Chinese management of enterprises, essentiallly foreign in character, is not the least uncommon. It is thus evident that even a brief connection with engineering or manufacturing developments there, must afford considerable, if not ample, grounds for study of the question of Chinese labor.

I was occupied in China for more than a year on work connected with a large industrial establishment in which were employed native workmen, including stokers, enginemen, electricians, fitters, machinists, masons, carpenters, and coolies. Of this staff I had direct supervision and consequently was thrown in daily contact with the men and their work. A large percentage of the craftsmen were trained in the great ship and engine building shops of Farnham Boyd & Co., in Shanghai, a schooling comparable to that afforded by similar organizations in England and America. Therefore, a sound basis was gained for the general comparison of the performance of Chinese skilled labor with that of occidental countries.

The average foreigner compelled for the first time to struggle with the labor problem in China will, after a brief experience, be possessed of some two or three remarkably distinct impressions in the general confusion of ideas. If it constitutes his introduction to the Chinese people, he will probably be struck first by the differences between individuals. Whereas he has pictured the Chinese as cast all pretty much to the same mould, he will find that they display quite as much individuality as Western peoples. Secondly, he will descry, usually only under some especial stress, however, evidence of surprising cleverness, not only at imitation, but at creation. Finally, he will come to the conclusion (if he is not forced to it) that these beings whom he had thought of before almost as creatures apart, are after all surprisingly human.

Naturally pre-eminent among the skilled craftsmen of China, the carpenter still maintains the leadership. Though almost invariably wedded to the use of the tools of his ancestors and to their methods, judged by results he is more efficient in his line than are the average of the foreign trained fitters and machinists in theirs, though a constant diminution of the difference is in progress.

In judging the performance of the native workmen, it is almost impossible to avoid the popular bias that addiction to their own methods and tools invariably bespeaks fatuous conservatism. Though this is in many cases true, it will often be found on careful observation that what has passed for a stubborn blindness to the virtue of innovation, is in reality a keener perception of comparative merits than the judge himself was aware. This is particularly true of Chinese carpenters. While most of their commonest tools differ in some radical way from our own, it is never safe to assume the superiority of the Western product. Their small ax for example, is a beautifully balanced tool, and they are remarkably adept in the use of it, being able to work as true a surface therewith as can be obtained with an adze in the hands of the white man. On heavy work it is customary for two to hew together on opposite sides, striking alternate blows. Both hands are used and the recover is over the shoulder, alternate right and left. There is a freedom of swing with an accuracy of delivery that is a treat to watch, and the rapidity of blows is almost bewildering.

With the introduction of the nail into his craft, the Chinese carpenter was in need of a hammer. His ax is provided with a sort of hammer face, so he came to use that. Though a good ax, the tool is a bad hammer. However, a large proportion of the hammers first introduced from the West by importers were poor imitations of what a hammer should be, and the Chinaman rightly judged it no better than his own, so generally repudiated it. Here was another evidence of so called obduracy. At a venture, I secured a small consignment of thoroughly good claw hammers for trial with my own men. Shortly thereafter a man chanced to lose his ax-hammer at a juncture where it was very badly needed in the latter function. I presented him with one of the new lot. He "hefted" it and swung it with a grin of dawning satisfaction. When I made the next round he was wielding the new acquisition with energy.

In the course of a few days there occurred again the loss of a native tool, which resulted in the presentation of another of my hammers. At the third occurrence of the phenomenon my suspicions were slightly aroused. Upon the fourth, I decided it was time to begin an investigation. These hammers seemed the source of a rare satisfaction.

It was arranged to begin prematurely, a phase of the job in hand which required a great deal of ax work. After giving directions, I retired to watch developments. There was a rather ostentatious struggle to meet the demand of the work with a short supply of axes. Then the boss-carpenter made a plea for a new supply, which was refused; moreover, he was told that as some of the men seemed to be loafing, it might be just as well to reduce the force. Alarmed at this possibility of a reduction in his own "squeeze" he took another course. One by one, when my back was turned, the lost axes were unearthed. Judicious intervals were interposed between the respective recoveries but that was merely "face pidgin." They knew that I was in no way deceived, but so long as I had no actual proof, their "faces were saved." They were all immensely pleased when they were permitted to keep the new hammers. The remainder of the force was likewise equipped, and thereafter the work progressed smoothly and satisfactorily.

The boss-carpenter referred to in this connection was both the finest workman and the best executive among the native artisans in the establishment where I was engaged while in China. More than that, he was instinctively a gentleman and the part he played in the above outlined episode could not be held reprehensible by anyone at all familiar with the Chinese ethical code. To me his virtues quite transcended the stigma of that petty artifice. But this is a digression.

There was undertaken in the plant of the organization, the design and installation of a cooling-tower condensing system. The cooling tower was constructed complete from timber in the rough, only the pumps, fans, etc., being brought out from home. This was the first plant for the continuous use of condensing water installed in North China, and to the best of my knowledge the second or third in the Empire, so that it was a complete novelty to our workmen.

It may be well imagined, then, how much of its ultimate success was dependent on the receptiveness of the Chinese mind. The mainstay in the execution of this important work was the boss-carpenter, who quickly absorbed, not only the proposed structural features, but the utility of the cooling tower. It must be confessed that he arrogated to himself the functions of construction superintendent, and bossed carpenters, masons, and fitters alike, with a surprising absence of friction. Even design was not beyond him, and he evolved and submitted a very clever device for the compensation of expansion of the timber in the tower, under the influence of moisture, which was adopted and worked ideally. Certainly this case was an exceptional one, but it amply demonstrated that in the Chinese working classes there are men without foreign training who are fully capable of taking active leadership in the industrial regeneration of China.

This man was a Northerner, a Manchu, of a race generally believed to be less astute and less energetic than the Southern Chinese. In the present state of industrial development this would appar to be so, and it is a curious contradiction of the usual relationship between people of temperate and tropical or semi-tropical climates. Its exceptional nature raises a very reasonable doubt of the permanency of the ascendency of the Southern Chinese in trade and industry. They do, however, display a consistency of energy unusual in inhabitants even of semi-tropical countries, and for this reason may continue their domination of the Empire.

The commercial superiority of the men from south of the Yangtse River is practically duplicated in the trades. So strong is the tradition, that no Southerner beginning business for himself in the North, whether he be shipwright, foundryman, or cobbler, would fail to include in his shingle a statement of his native habitat, and there is a deal of genuine provincial *esprit-de-corps.*

As might be expected, this sectional feeling is sometimes accounted a source of trouble where both Northerners and Southerners are engaged on the same work, but I suffered so little personally in this respect that I should always be inclined to look further for the seat of difficulty.

Considerate treatment is undoubtedly an important factor, and many plant managers court disaster by brutal treatment of workmen. In this case considerate treatment is not meant to imply kindness in any decided degree, but principally justice. The Chinaman is keenly appreciative of the "square deal" in everyday life, but he is nevertheless quick to take advantage, like all Orientals, of any display of sentiment on the part of a superior. While manifest kindness is unsafe, a great many, far too many, plant managers, construction superintendents, and others having supervision over native labor, err on the side not of severity merely but of brutality. A large percentage of the superintending engineers on the China coast are ex-ship's-engineers who have naturally gravitated from employment in the coastwise trade, which is large, into land practice where the demand has at times been considerable. On shipboard it is customary to rule with an iron hand in the engine-room as well as on deck, and confined as he is, the Chinese hand has no alternative but to obey promptly if he would escape violent treatment. Ashore these tactics of superior might are obviously poor policy, but accustomed to the maritime practice as he is, the psuedo-superintending engineer very often fails to weigh the consequences of their use, even after much direful experience. In extenuation it must be said that the Chinese workman with his methods, especially if he be a bit raw, is beyond proper management the moment the least irritability is manifested. A creature of vast patience himself, a show of impatience on the part of one supposedly his superior nearly always appeals to his sense of humor, and if the show of temper be very pronounced it will likely elicit also his amused contempt. When this stage is reached a dead-lock generally ensues and forcing only magnifies its duration. It is best then for the "foreign man" to retire from the scene of action and allow matters to take their natural course for awhile. The natural impulse is to go to the other extreme and resort to force. In such case the spirit of passive resistance on the part of the celestial is quickly transformed into a genuine Occidental strike mood and he arises and departs with all his brethren. A strike due thus to wounded sensibilities is always a more serious matter than a strike over wages or the like, because his dignity, or his "face" as he calls it, is absolutely the Chinaman's valued possession. It is almost impossible to persuade workmen so offended to return on any terms, and the unfortunate manager must gather a new force as best he may—not always an easy task to accomplish on short notice, especially if it be a case of skilled labor.

In the plant where I was engaged during the most of my stay in China there was little or no serious friction of the above sort, this freedom being due undoubtedly to more causes than one. First, it was an unwritten rule never to use the slightest semblence of force except in cases of palpable insubordination. In many other establishments in the neighborhood employing numbers of natives, incompetence was not sufficiently differentiated from insubordination in its reception—a very great mistake. While we were, on several occasions, compelled to resort to physical force in cases of obstreperous spirits bent on mischief, the justice of such action was never once questioned by other workmen, though they were often members of the same guild, bound by ties not unlike those binding the members of our own labor unions together. It was partially the thought of this fact that called forth the previous remark regarding the Chinese appreciation of justice.

Another factor or rather condition tending I believe to render us immune from labor difficulties was the racial division always carefully preserved in our force. Half northerners or Manchus and half southerners, Shanghai or Ningpo men, was the rule, simple in itself but certainly rather bizarre in its working. Whereas one would be apt to expect endless trouble from sectional jealousy, the sectional or provincial *esprit-de-corps* being so very strong, there resulted only a healthy competition between the factions. Immediate personal contact, and therefrom the opportunity to disagree and make trouble, were prevented by the arrangement of the various gangs according to race, each gang being made always homogeneous. Whenever it was necessary to employ men from both factions on the same piece of work, the supervision of a white man was invariably a part of the programme.

The strength of the provincial fellowship as contrasted with the lack of national spirit in the Chinese is a source of constant speculation to any thoughtful foreigner dealing with the Chinese. It seems almost inevitable that with the supply of an ample system of railways and telegraph lines in China, this provincial sentiment of kinship must ultimately be transformed into a national patriotism as strong and enduring as any the history of the world records today. But the interval is a vast one and will demand much bridging. For example, a Cantonese of the middle class at the present time looks upon the far Northerner, even after considerable personal acquaintance, as a being of racial attributes distinctly foreign to his own.

Returning to the topic of the distinctive proficiencies in the various crafts a great deal might be said. Fitters and machinists have been given the reputation very often of inaccuracy, but personally I have never seen one, thoroughly trained to an understanding of the necessity for accuracy, who was not quite as reliable in that respect as the average Western workman and I have seen some convincing examples of native ability to turn out big work where accuracy was by all means the prime consideration. One instance in point was a job of sheathing with gun metal a large hydraulic ram 30 inches in diameter and several feet long. The sheath was separately cast and machined to fit, and so accurate was the machining that it was slipped on with less than 1,000-pounds pressure, the pressure *apparently* bearing a simple and smooth relation to the travel of the sheath over the iron core. On other occasions too I have quite marvelled at the delicacy of touch of the Chinese machinist while calipering. This sheath itself by the way bore testimony of a native foundryman's proficiency. It was very nearly as hard as I have ever seen even in a small casting, and was at the same time practically flawless when finished, though it was turned to a thickness of only ⅝ inch. This entire work, including founding and machining, was executed absolutely without the participation of any foreigner, in the works of the Chinese Engineering & Mining Company at Tongshan, near Tientsin in the province of Chili.

Even so superficial a treatment of the broad subject as the present must include a word regarding wages and hours. The standard of wages for men is the equivalent of 25 cents per day, United States currency, for all skilled labor, and 12½ cents for unskilled. The question of hours is a more variable quantity. When working for himself or for a native employer, every minute of daylight is utilized, only the deliberate working pace permitting the maintenance of such long hours. When working for a foreign employer, the standard working day is generally ten hours, though exceptions to this rule occur sometimes when the employer is blessed with conscientious native foremen who will maintain the long hours themselves and keep the rank and file up to the scratch adso. In the observation of Sunday as a day of rest there is great diversity of practice. In the centers of modern industry such as Shanghai the observance of Sunday as a rest day has become the rule, but in more isolated regions where the foreign influence is not strongly felt, only the occasional Chinese holidays are observed, culminating in a solid three-weeks' shut down at the Chinese New Year season.

In times of special stress, speaking of the maintenance of work, the Chinese ability to labor constantly with scanty rest is remarkably demonstrated. In one instance that recurs to me we had a bad engine smash-up centering about a broken connecting-rod. The attendant calamities were numerous and nerve-trying. It required an even forty-eight-hours work on the part of the whole engine-room staff to clean up the situation, and the average of respite for sleep and refreshment during that time was less than three hours. The boss-blacksmith, upon whom the bulk of the work devolved, was constantly afoot during the whole of the time. Possibly most remarkable of all, there were but two or three inconsequential expressions of complaint heard in all the force.

Experiences of the kind cited in this brief review certainly justify a fair measure of optimism in estimating the future of the Chinese, as they are now being tried and will further be tried in an ever increasing variety of modern industrial vocations as the material welfare of the Empire advances.

EDITORIAL COMMENT

IN considering the possible traffic through the Panama canal it may be of interest to examine the manner in which the business of the Suez canal has developed, and the manner in which it has been found necessary to increase the capacity of that waterway.

Thus, in 1875, there passed through the Suez canal 1,494 vessels with a total capacity of 2,000,000 tons, and in ten years' time the traffic had increased to 3,624 vessels and more than 6,000,000 tons. Then the influence of the increase in the size of vessels appears, for by 1895, ten years later, the number of ships had actually diminished, being 3,434, while the total tonnage had increased to nearly 8,500,000. The report for 1904 shows the passage of 4,237 vessels, with a total of 13,400,000 tons, of which three-fifths was represented by British vessels, and the traffic for 1905 is placed at 19,000,000 tons. The receipts of the canal from tolls grew from 26,000,000 francs in 1875 to 76,000,000 in 1895, and to 113,000,000 in 1904.

The traffic through the canal, indeed, furnishes a sort of comprehensive view of the commercial development of the world. England, as noted above, has steadily maintained her three-fifths of the total; Germany has trebled her tonnage in ten years, while France has barely doubled in the same period, losing her former post of second in rank. Japan, from a beginning of two ships, 2,350 tons, in 1895, rose in 1903 to fifty-three vessels of a total tonnage of 220,966. The United States is negligible; its figures are so small as to be merged in the "miscellaneous".

In order to meet the increase in traffic there has been an almost continual effort to develop the capacity of the waterway. The depth in 1883 was 8 metres, with a width of 22 metres. At the present time the depth of 9 metres has been effected for nearly the entire length, while the minimum width is now 37 metres, and the minimum width on curves has been increased to 52 metres. Before the introduction of the electric-lighting system, making it possible to continue navigation after nightfall, the duration of the traverse was about forty-eight hours, while the increase in dimensions of the canal prism, and the ability to proceed by night as well as by day has reduced the time to an average of eighteen hours.

The grounding of vessels formed a serious matter in the early operation of the canal, but at the present time the groundings have been reduced to 15 per cent of the total number of passages, and but 3 per cent if we include only those ships which are unable to release themselves and must be aided by the special appliances of the Company.

At first the charge for passage was 10 francs per ton, but with the increase in traffic this has been reduced so that it now stands at 7.25 francs per ton, upon the registered tonnage of the vessel, whether fully loaded or not.

An important fact, bearing upon the work now being conducted at Panama, appears in the greatly improved sanitation of the Isthmus of Suez since it has been under the control of the canal Company, malarial fevers, formerly prevalent, having been very greatly reduced by the efforts of the Company.

It is to such developments that the Panama commission may look for encouragement and guidance, and although there is no such immediate source of traffic for Panama as existed in the case of the British commerce with India via Suez, there is every reason to believe that the established law that "facilities create traffic" will operate at the one isthmus as it has at the other.

* * *

One of the pressing problems of the day in all great cities is that of the relief of the congestion of the streets in the business and commercial quarters—a problem which is daily becoming more and more complicated with the introduction of motor vehicles, and with the erection of crowded tall buildings. The introduction of various methods of rapid transit, whether by the use of elevated railways, subways, or extended surface traction, continually tends to increase the congestion on the sidewalks and at the crossings, making traffic more and more difficult, and increasing the very troubles the improvements were intended to relieve.

The real difficulty at present appears to be the foot passenger, and doubtless if it were not for him the traffic upon the streets could be accelerated many times, both by permitting rapid and unimpeded speed on the part of vehicles, whether horse-drawn or mechanically propelled, and by allowing free access from delivery teams to and from buildings, regardless of the obstruction of the sidewalks.

If, then, the congestion in business streets is to be relieved the foot passenger must go. But whither can he be sent? Some have taken hint from the present disposition to put everything underground, and insisted that subterranean footways, possibly accelerated in capacity by the addition of traveling sidewalks, are the only method of relief. For brief periods this may do, but not as a complete solution of the whole question. Fortunately there is another solution, one which, from its numerous advantages, should appeal to all elements in the community. Instead of placing the sidewalks below the surface they should be placed above, on a line with the second-floor level of the buildings, forming a second street level, so far as the foot-ways are concerned, and leaving the middle of the street clear. This plan should provide an elevated structure on each side of the street, light in construction, being strictly reserved for foot passengers, giving access to all the shops and buildings along the route, and thus doubling their entrance capacity, while at the same time leaving the street level below entirely clear for vehicular traffic. All cross streets should be spanned at the second-floor level, so that no grade crossings need be made, and with such a provision for the foot passenger, he should be permitted on the surface level only at his own risk.

* * *

Architecturally, this plan for a double-decked city has much to recommend it. In many places the idea of street arcades has been employed for no other reason than to obtain the effect which is produced to the eye, and the colonnades of the Rue de Rivoli in Paris, the arcaded streets of the old city of Bologna, and the "rows" of Chester may be cited as examples. In more modern times the examples of the "board-walks" of many of the seaside resorts give some idea of the manner in which the most crowded streets of the most densely populated cities might be rendered free from discomfort, while at the same time the access to the buildings would be doubled and the streets left clear for high-speed automobiles and electric railways. Instead of placing the heavy and noisy electric railways upon an elevated structure, itself necessarily unsightly and expensive, the proposed plan would give the solid ground to the heavy traffic and lift the lighter load to the higher level in a manner which would permit an artistic incorporation with the design of the buildings by the way, adding greatly to their value and accessibility, instead of placing a hideous and noisy structure under their windows.

An important consideration which appears in connection with the idea of elevated sidewalks for foot passengers is the fact that it may be put into operation gradually, and portions may become available immediately, without waiting for the completion of the entire structure. In the more crowded business districts such elevated sidewalks might be erected without delay, descending to the surface level as the less congested portions were reached, the elevated walk being continued as building improvements and business activity progressed. In this respect, as in many others. the elevated plan has a vast superiority over any subway scheme, the latter including the completion of the greater portion of the work before any of it could be thrown into service. In any case it is most important that the great bulk of the public should be given place in the outer air, above the dust of the street, and freed from the surface accumulation. The elevated sidewalk could gather but a trifling amount of dirt, as compared with the possibilities of the surface street, with its sweepings and animal droppings ; and if, as might well be considered, the elevated structure were made of reinforced concrete, it might readily be washed clean from all refuse at small expenditure of labor and time.

* * *

Both pedestrians and vehicle owners should perceive that it is useless to enter into conflict as to their respective rights upon the streets. Both methods of locomotion are essential, and neither should be permitted to interfere with the other. In the automobile we have one of the most potent appliances for the development of civilization which can well be conceived, and any attempts to restrict its capabilities must be considered as altogether undesirable, ill-advised, and futile. This being admitted, it remains to permit full freedom of development to the mechanically-propelled vehicle, and at the same time give increased freedom, convenience, and satisfaction to the pedestrian, himself in many cases also included among the owners and users of the automobile.

Conceding the right of each class of the community to do as he pleases without interfering with the right of the other to do as he pleases, we have a solution of the problem in the elevated sidewalk and the open and unimpeded surface street—a solution which should appeal alike to rider, driver, pedestrian, merchant, and architect, giving increased opportunities to all, while detracting from none, and adding to the value of the city for every dweller and visitor.

* * *

If, as we have heretofore deplored in these pages, we have been lamentably slow as a Nation to free alcohol from taxation so far as to enable its use in the arts, and especially as a fuel, we are at last promised a vigorous awakening. The Department of Agriculture has promptly recognized the conditions opened by the recent passage of the Free Alcohol Bill, by arrangements for the issue of a special bulletin, to appear January 1, 1907, thus giving to the public, at the very moment the new law goes into effect, the fullest and best collection of data obtainable concerning the use of alcohol in small engines. The bulletin will contain all the work done in this field, both here and abroad, together with a complete bibliography of the literature of the subject, and a record of the results of experiments and the conclusions to be drawn therefrom as to American practice and opportunity.

Dr. Charles E. Lucke, whose striking investigations of the gas turbine form the topic of the leading article in this number, has been retained as the expert in charge of the study and experiment, and the work will be carried on in the laboratories of Columbia University. Its scope is so extensive that Dr. Lucke is most anxious to secure the freest possible co-operation of everybody interested. He will cordially welcome data, or information as to the location of data which may be uncovered by further search. Owners of patents are invited to communicate with him, and any who way have vaporizers, carburettors, or complete engines are earnestly requested to submit the devices for test in Dr. Lucke's laboratory. The tests will be carried ont without any expense whatever to the public, except the bare cost of transportation, and the results will be published in the bulletin.

Due acknowledgment will be made of all assistance given, and all apparatus and materials will be retnrned when the work is completed. Correspondence and shipments should be addressed to Prof. Charles E. Lucke, Columbia University, New York City.

A large measure of the value of the new legislation depends upon the promptness and energy with which engineers and manufacturers attack the problems and avail themselves of the opportunities. The Government in this instance has certainly shown admirable, not to say unusual, readiness of initiative. It is greatly to be hoped that the response from individual inventors, investigators, and manufactnrers will be correspondingly active and energetic. Certainly the policy from which all have most to gain now is that of full publicity and co-operation, Competition and rivalry should be confined, for the present, to seeing who can offer most for the public information and education.

* * *

The Annual Statistical Report of the American Iron and Steel Association for 1905, presented to the members on June 30, contains an almost bewildering picture of the enormous industrial activity of the year covered by its data. We could wish, perhaps, that the Association would supply a ready key to the vast field upon which its figures are assembled, by furnishing an index. The table of contents is only a general guide, leaving the searcher for some special fact under the necessity of making his own detailed exploration of the section into which the table directs him.

The huge fact which dominates the whole report is the increase—"simply marvelous," indeed, as the report styles it—in the production of iron and steel in the United States, as compared with 1904. Pig iron jumped from 16,497,033 tons to 22,992,380 tons, and steel from 13,859,887 tons to 20,023,947 tons. Rails alone rose from 2,284,711 tons in 1904 to 3,375,929 tons in 1905; but as the increase of new mileage on steam roads was about the same during the latter year as during the former, the extra consumption appears to have gone into electric lines or the relaying of old track with heavier steel. In contrast with former experiences during the boom times in the industries of the country, it is very noteworthy that prices advanced but little. Rails, of course, were kept at the uniform price of $28.00 which has been maintained by the mills since 1902. Bessemer pig at Pittsburgh rose from an average of $13.76 in 1904 to $16.36, average, in 1905, and steel billets from $22.18 to $24,03. As compared with the prices of $20.67 for Bessemer pig and $30.57 for billets which ruled in the average at Pittsburgh during the prosperous times of 1902, the figures for the last year look modest indeed.

Another interesting point is the sudden up-curve in the production of Bessemer steel, which up to the year 1905 had been steadily declining from its former maximum of 9,138,363 tons in 1902. In 1904 the output was but 7,859,140 tons; all the increase seemed to be going to the open-hearth process. In 1905, however, while open-hearth steel rose from the 5,908,166 tons of the preceding year to 8,971,376 tons, Bessemer leaped past it to a total of 10,941,365 tons.

Even the steady gain of the basic over the acid process in the manufacture of open-hearth steel, which has been so noticeable during the years since 1896, suffered a check and appears as a fraction of one per cent only. These phenomena seem to indicate the return to the active use of obsolescent plant under the stimulus of unusual demand.

The production of iron and steel in the United States alone in 1905 exceeded the output of the whole world in 1887. In marked contrast with Great Britain, it was manufactured wholly from domestic ores, and consumed almost wholly in domestic manufactures. In view of the enormous increase in the rate per capita, we might well recur to the question propounded by J. Stephen Jeans, writing in this Magazine some years ago—how long can it last? And closer than that stands the problem more recently proposed by James J. Hill: what of the time, perhaps not far distant, when our exploitation of natural resources outstrips the development of the country and its internal demand? Sooner than we expect, perhaps, we may find ourselves in need of those now lightly esteemed markets of the world.

We may find the wresting of foreign trade from well intrenched European rivals a more serious task than the protection of home markets against their entry. Prudence demands at least that we take stock of our equipment and our tactical position in case the battle should change front. There are some who hint that we are falsely secure even in the matter of our mechanical pre-eminence—that we are slowly being enslaved by over-indulgence in systems and standards, excellent within bounds, but tending to ossification and atrophy. In our September issue we shall present a striking and thoughtful article by Dr. Louis Bell—a plain-speaking, fearless search into the truth of the American position and system, which we believe will open the eyes of many of our industrial leaders to the fact that times are changing, and we must change with them.

We believe Dr. Bell's arraignment and exhortation will be the starting point of a wide-spreading movement for the reawakening of the mechanical industries of the country, and we commend it most earnestly to all our readers who are justly proud of the progress the Nation has made in material civilization, and jealous for the maintenance of our lead in the things which belong to the province of engineering and mechanical industry.

* * *

In the death of Charles Paine last month, the engineering profession lost a leader of rare type—a man in whom professional ability, literary talent, and æsthetic perception were all co-ordinate and all highly developed, but who impressed most of all by his broad humanity. His friends loved him for what he was as much as they respected and admired him for what he did in the direction of large affairs. It was good to see how the faces of his associates would kindle with pleasure at the mention of his name.

It *was*—rather let is say it *is*, and will continue to be. He is not one whose memory will die out of the hearts of those who knew him.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

MUNICIPAL OWNERSHIP OF ENGINEERING UTILITIES.

THE ORIGIN, MEANING, AND PROPER TREATMENT OF THE AGITATION FOR MUNICIPAL OWNERSHIP IN THE UNITED STATES.

Everett W. Burdett—National Electric Light Association.

IN view of the present spirit of unrest and discontent regarding the operation of public utilities in the United States, leading to the agitation for municipal ownership of enterprises hitherto mostly conducted by associations of private capital, the thoughtful address delivered before the National Electric Light Association by Mr. Everett W. Burdett demands attention.

Mr. Burdett admits that there has been good reason for adverse criticism, and refers to the manner in which, in certain instances, there has been just objection to the manner in which corporate organizations have abused the confidence which has been placed in them. This, however, is but one side of the question, and the other side should be given fair consideration, before the advisability of transferring the control of public utilities to municipal control should be conceded.

"Forgetting the beneficent results which have been obtained only through the accumulation of great wealth derived from corporate organizations, the dissatisfied citizen sees only the abuses of financial and corporate power of which he has been, or imagines himself to be, the victim. The very word 'corporation' has come to have an opprobrium of its own.

"And yet, of course, this wholesale distrust and condemnation of wealth and corporate power is unreasonable. It loses sight of the fact that we are unable to assert from what other source the people at large would have derived the blessings which have come from the establishment and maintenance of the almost countless hospitals, libraries, colleges, parks, museums and special funds for the encouragement of learning, the promotion of science, the reward of courage and endeavor, and the various other beneficent uses for which they have been established and maintained by private wealth, largely derived from corporations. They forget that it has been only by the uniting of the funds of the rich and the savings of the poor in corporate organizations that the country has been developed by the establishment and exploitation of numberless forms of industrial enterprises, which have given employment to labor, activity and volume to trade, and a market for all the products of our soil and all the talents of our people.

"In electrical enterprises the central station electric lighting investment in the United States alone already aggregates 700 million dollars, involving an annual operating expense of nearly or quite 100 millions. distributed among all classes of workmen and through every artery of trade. The census reports show that in the single year 1904 there was an output of new electrical apparatus of the value of more than 150 millions. There are nearly 5,000 central electric lighting stations. There are 23,000 miles of electric railway, carrying each year over 5,000 million passengers. A network of nearly 300,000 miles of steam railroad gridirons the country, transporting upward of 750 million passengers annually. Spoken words are transmitted through more than five million miles of wire, by the use of more than three million telephones, by which more than 5,000 million messages are transmitted yearly.

"All these wonders we owe to corporations. They have given free play to the enterprise and individual energy of our people, and have made that enterprise and energy vastly more powerful and effective than it otherwise could possibly have been. They have enabled the man of small means to do a part of the world's work by joining his savings with the capital of his wealthier neighbor. They have encouraged thrift and the spirit of investment. They have advanced civilization and brought to every man's door the diversified products of our own and other countries."

Mr. Burdett calls attention to the fact that the principal beneficiaries of the development of corporate organizations have been, not the organizers, managers, and stockholders of these enterprises, but the general public, and that the community at large has obtained vastly greater benefits from corporate enterprise than have those whose money has made them possible. A comparison of dividends paid with services rendered shows the truth of this statement, and demonstrates that the tax-gatherer, the employé, and the general public have each and all reaped rewards vastly greater than have been realized by the stockholders in the enterprises. The existing widespread agitation for the municipal ownership and operation of public utilities may really be attributed to the influence upon the popular mind of the widespread dissatisfaction and resentment occasioned by the abuses of great wealth and corporate facilities. To this must be added the skilful use of this dissatisfaction by politicians, seeking to turn public opinion to the advancement of their own ends.

"In pointing out the fallacy of adopting municipal ownership in the United States on the strength of its alleged successes abroad, the first thing which is to be suggested is the danger which always lies in the offhand adoption of foreign methods, laws or practices in another country. It can seldom be done successfully. Differences in political, economic or social conditions almost always exist which render the transplanting of the customs or methods of one country into another inexpedient.

"As contrasted with American municipal service, that abroad is less political and more business-like in its character, more certain in its tenure, more continuous in its service and more disinterested in its activities. Its desirable features are not only secured and protected by law, but are demanded by public sentiment. While the raw material is perhaps as good or better in the United States than in the European cities, it is handicapped in its efficiency by its political character and the uncertainty of its tenure. The American municipal servant never knows how long he is to be permitted to hold his place and is subject to constant changes in policy and supervision. The only thing he can be reasonably sure of is that his head will ultimately drop into the basket. This system, for system it has come to be, may perhaps prevent dry rot and some of the evils of bureaucracy, but it is at the expense of efficient public service."

An examination of the operation of municipal ownership in Great Britain does not give positive assurance as to the success or failure of the system in the United Kingdom. In some instances, in electric lighting, for example, a little more than one-half of the municipal undertakings have showed a profit, while a much larger proportion of private enterprises have been found profitable. It is not by financial returns alone, however, that a system is to be judged. A well managed system shows its efficiency by the extent and nature of its development, by the completeness of the public service rendered, and by the real additions to the wealth of the community which are effected by its operation. Judged by this standard the operation of such utilities as electric lighting, telephone service, electric power distribution, and the like, by municipalities, cannot compare in efficiency with the work of private corporations. In support of this view Mr. Burdett refers to the action of the Institute of Electrical Engineers to endeavor to overcome the restrictive action of local authorities upon the development of the electrical industries in Great Britain.

"The remedy for existing conditions must come from both within and without. The companies interested, the public authorities and the public at large must each contribute to the solution of the problem. None of them can or will be wholly effective without the others. Human nature is such that it can not be trusted to regenerate itself, public clamor is frequently ineffective, while enactments of the legislature can not accomplish all that is desired.

"In the first place, the companies engaged in furnishing public services must, in their own interests, strive more and more to give good service at fair rates. While they can not all avail themselves of the advantages of the legal so-called sliding scales, they can hope for the best results only along the line of the theory of the sliding scale. In my judgment, the time has gone by, if it ever was, when extortionate rates and wretched service will promote the interests of the corporations. He who serves the public best serves his company best. Patience and a spirit of conciliation, and a real desire to increase facilities and reduce charges as rapidly as consistent with such management, will ultimately bring their rewards in the form of increased earnings and larger dividends. And when the public, in any given community, comes to see that, notwithstanding the mouthings of the demagogue and the agitator, it is being fairly treated by the corporations, its objections to large and increasing returns upon invested capital will gradually disappear.

"Next: the abuses of great wealth and corporate privileges to which I have alluded must cease, or at least be greatly mitigated. Self-interest must realize the fatality of a continuance of the abuses involved in gross over-capitalization, poor service, high-prices, discrimination among consumers and above all the attempt to control the law-making power for purely selfish ends.

"Third: Public sentiment must be cultivated. The one great need in the economic world, is popular education along sound economic lines. Let us no longer leave the exploitations of vital economic principles to the visionary or the doctrinaire, on the other hand, or to the irresponsible politician or selfish agitator, on the other. A real campaign of education is what is needed, a broad, comprehensive, intelligent, persistent, aggressive and well-directed campaign, which shall leave nothing in reason undone to spread sound economic doctrines. So far as self-interests enter into it, let it be an enlightened self-interest, having in mind the rights of all; let it be devoted to the fundamental proposition that all members of the community are bound together in such intimacy of relation that no member can ruthlessly injure another without ultimately feeling the recoil upon himself. 'Live and let live,' should be the motto."

POWER GAS FROM LIGNITE FUEL.

PRACTICAL EXPERIENCE IN THE GENERATION OF FUEL GAS FOR COMBUSTION MOTORS FROM THE BROWN COALS OF GERMANY.

H. Neumann—Verein Deutscher Ingenieure.

WITH the development of the internal combustion motor there has come a corresponding interest in the provision of a cheap and satisfactory fuel for such machines. We have seen how the agitation for a suitable and abundant liquid fuel for such motors has resulted in the liberation of alcohol from an onerous and unnecessary tax in the United States as in other countries, but there are fuels available which have not been sufficiently developed, and for which the combustion motor is especially well adapted, and among these we must include those partially carbonised fossil fuels, indifferently known as brown coal, lignite, peat, and the like. The prevalence of such fuels in Germany has led to an examination of their availability for the generation of fuel gas, and in a paper recently presented before the *Verein Deutscher Ingenieure* by Herr H. Neumann this subject is given careful discussion, including practical details of gas producers, scrubbers, etc.

Lignite, or brown coal, forms a very important portion of the natural fuel deposits of Germany, coming close behind bituminous coal, the present yearly output of lignite reaching 48 million metric tons, of which 38 million tons are produced in

Prussia and the balance in the rest of the Empire. There are also large deposits in Bohemia, and in other parts of Europe. A portion of this fuel supply has been available by briquetting, and it is estimated that about ten million tons are thus prepared in Prussia alone. This method is not always available, however, and any way in which lignite may be efficiently used as a power fuel is certain to be welcomed as of great economic importance, both to Germany and to the rest of the world.

The employment of the gas producer as a means of preparing fuel for the internal combustion engine has, until recently, been assumed to be limited to work in which either anthracite coal or coke was available as fuel. With bituminous coals the action of the producer is found to be irregular and uncertain, involving much barring and poking to prevent caking and obstruction, while the production of tar and other impurities has rendered the gas unsatisfactory.

The high price of anthracite, however, has led to persistence on the part of designers of gas producers and appliances to adapt the apparatus to the use of cheaper fuels, and it now appears as if the whole field of power-gas machinery has been opened to the use of the cheap and plentiful brown coal, hitherto of but limited utility.

In Germany the lignites appear in various forms and constitutions, some deposits furnishing large blocks, others masses of distinct woody structure, others again in lumps of earthy nature. A tabular view given by Herr Neumann shows that the German lignites contain from 40 to 80 per cent of combustible, with 60 to 80 per cent of moisture and ash, the non-combustible solid being generally in a small proportion, rarely more than 5 per cent. The calorific value of these brown coals ranges from 2,000 to 5,600 calories per kilogramme, corresponding to 3,600 to 10,000 B. T. U. per pound. The large proportion of water contained in some of the lignites renders it desirable that they be partially dried and compressed into briquettes before transportation, from 15 to 17 per cent of moisture being retained in the compressed blocks.

Such a fuel, when gasified according to the ordinary processes, produces a number of auxiliary products of distillation, such as paraffine, tar, creasote, etc., these passing, in a volatilised condition, out with the gas. Although these by-products may have a technical value, they are undesirable in connection with the generation of power gas, and when separated are so diluted with water as to render their utilisation a matter of too great cost to render them of commercial value.

Two methods may be adopted in dealing with such products in the generation of fuel gas; the lignite may be gasified in the ordinary manner, and the gas then passed through various purifying devices to remove the volatile elements; or the producer may be so designed as to convert the tarry products into fixed gases, forming a portion of the gaseous product. The former method permits the use of almost any type of generator, while for the latter process a specially designed producer is necessary.

In the earlier gas producers for use with lignites, the principal effort made was to provide for the removal of the slag and cinder, such methods as the provision of an iron, water-cooled, hearth, to which the slag would not adhere, or a totally removable hearth mounted on a wheeled truck, being employed. These arrangements made no provision for the gasification of the tar, etc., but involved the employment of subsequent operations of condensation, scrubbing, and purifying. Such producers have been made and operated successfully by the Deutz-Otto gas engine works, and tests by Professor Meyer, using Lausitz brown coal, containing 29 per cent of carbon, and 58 per cent of moisture, showed a gas of 1,272 calories per cubic metre, or 143 B. T. U. per cubic foot. Including gas engine tests it appears that the fuel consumption was from 1.5 to 1.6 kilogrammes per horse power, which is excellent when it is considered that the lignite itself had a calorific value of only 2,190 calories per kilogramme, or about 4,000 B. T. U. per pound; the power cost working out only about 0.6 pfennig per horse power per hour.

For the proper generation of fuel gas for internal combustion motors from lignites, however, it is desirable that the tarry products be wholly converted into fixed gases, and two general processes are available for this purpose: either the tarry vapors are passed directly through an incandescent layer of fuel, or they are first burned, and the products then delivered into the burning fuel.

In the first case the hydrocarbons are decomposed into hydrogen, carbon, and methane, the carbon being separated in the form of soot, and then, in the presence of oxygen, converted into carbon monoxide; in the second case water and carbon dioxide are produced by the combustion, and these subsequently converted in the fuel bed into carbon monoxide and hydrogen. In many cases both operations are carried on together, when the tarry vapors are delivered, together with oxygen, into an incandescent layer of fuel.

Four different arrangements of gas producers have been devised in connection with the gasification of lignites for power-gas generation.

1. Simple gas producers in which the tarry gases are returned into the combustion chamber;

2. The combination of a simple gas producer with a separately-fired reduction furnace;

3. The reversed-draught generator, in which the air enters at the top and passes downward, the gas being taken off from the bottom;

4. The double-combustion generator, in which, in one and the same producer, the air is admitted from above and from below, the gas being drawn off between.

Herr Neumann gives a number of illustrations of gas producers designed according to these principles, with details of construction.

Especially interesting is the experimental research generator built by the Otto-Deutz company for the investigation of different kinds of fuels. This consists of two separate gas producers, one for the production of the mixed gas and tarry vapor from lignite or brown coal, while the other is a regular producer arranged for coke or anthracite coal. The latter is provided with tuyeres above the grate, for the admission of a determinate quantity of air, while the gas and vapors from the lignite in the first producer are delivered below the grate and pass up through the shaft of incandescent fuel. With this apparatus the proportion of coal or coke required to fix the tarry vapors for any variety of lignite can be experimentally determined, and valuable data obtained for the design of commercial producers.

In actual practice it has been found that the gas producer, using lignite with a calorific power of only 4,800 calories per kilogramme (8,640 B. T. U. per pound) gives a horse power in the gas engine with a consumption of 0.71 kilogramme, while a coal of 7,000 calories (12,600 B. T. U. per pound) burned under a boiler, and used in connection with a steam engine required 0.88 kilogramme per horse power.

AMERICAN RAILROAD OPERATION.

THE WORK OF THE MOTIVE-POWER OFFICER IN THE MANAGEMENT OF AMERICAN RAILROAD OPERATION

G. M. Basford—Purdue University.

IN common with several of the technical schools of the United States there has been established at Purdue University the system of presenting to the students some practical views of important departments of engineering work by independent lecturers of eminent standing. At Purdue especial attention has been given to locomotive work, this being the home of the first locomotive testing plant, developed under the care and effort of Professor Goss, and among the recent addresses recently given before the Mechanical Engineering Society under his charge we note that of Mr. George M. Basford, of the American Locomotive Company, upon the important subject of the work of the motive power officer in American railroad service.

The development of the locomotive during the past decade is a matter to which reference has frequently been made already in these columns, but Mr. Basford passes from this part of the subject to its natural sequence, the increase in scope and responsibility of the men in charge of the railway motive department.

"American railroads are usually built along the lines of least financial resistance and improvement problems in grade reduction and curve specification were handed down to the present generation of managements. Improvements in yards, at terminals and at points in transit simplify the handling of freight, and soon the locomotive will receive its share of development. Heretofore it has grown chiefly in size, weight and power, but there remains another development in the direction of crowding the greatest possible capacity for power within the possible limits of weight and size. Economy of operation, while important, is less important to-day than the provision of the utmost possible capacity of the machine. Perhaps this may be more clearly stated by saying that the greatest need is for that which will extend to the utmost the capacity of the fireman and render the limited physical strength of a man capable of supplying the requisite power.

"This is the locomotive problem for the immediate future—to provide more power without greatly increasing existing weights. A secondary, but scarcely less important field for effort, is the improvement of design and method of operation which will reduce road service failures.

"Another opportunity for the greatest abilities lies in revolutionizing methods of motive power management to bring them into parallel with those methods which have brought the greatest successes in the management of vast industrial establishments. Altogether the motive power problem presents possibilities as great as those of any field of mechanical activity and these are worthy of the efforts of the best of men.

"Thirty years ago the head of the mechanical department led a comfortable life. He could safely follow precedent and the strenuous life had not been invented. Labor wars had not begun and the stirring emergencies of the present were unknown. It was easy to select shop machinery. There was no shop problem, no pooling of locomotives, no piece work price, no heavy locomotive or large capacity car and no train four-fifths of a mile long. No one cared much about the records of performance or cost of work. Workmen were better trained and good apprentice systems were in force. There was no tendency to go outside of a railroad organization to secure any official, and railroad ways and methods were those of smaller days. There were emergencies, of course, but not the emergencies of to-day. Thirty years ago the railroad official was a good man and as efficient for the time as the official of to-day, but he was a very different kind of official. His facilities were crude and his responsibilities not so great. Locomotives did not weigh 50 tons and other factors were in proportion. The superintendent was his own general manager and he knew every man in the train service. The master mechanic knew all his shop men and the engineers and firemen. He knew their history and he knew all about them and their affairs. Each locomotive had a name and an engineer and fireman were assigned to it. They went into the shop with their engine or they were laid off while it was repaired."

In discussing the locomotive problems of the present, Mr. Basford considers the questions of compounding, superheating, modifications in valve gear, and articulated construction, as well as the materials and methods for car construction.

So far as compounding is concerned, he believes that it is advisable, and that it must be increasingly employed, not especially because of possible fuel economy, but because of the imperative necessity for increased capacity. The increasing weight of freight trains and the increasing severity of passenger schedules, these are the things which must be faced and met, and which, in the opinion of those most competent to judge, demand that the locomotive of the future must be a compound engine.

Superheating is not antagonistic to compounding, but aids in reducing heat losses, with corresponding improvement in economy, efficiency and capacity. With compounding comes also the advantages, in the four-cylinder engine, of balancing, this permitting hammer-blow action on the rails to be replaced by a practically constant pressure. Since this enables the weights on the driving wheels to be increased without a corresponding increase in destructive action on the track, this again permits larger boilers to be carried, an absolute essential to material increase in capacity.

Improvements in valve gears are largely included in the question of general design, since the steam distribution may be effected in a great variety of ways. The Walschaert gear has been in use in Europe as long as the link motion has been employed elsewhere, but it has been introduced generally in the United States only since four-cylinder compounds have rendered an outside gear desirable, and since the necessity for preventing further increase in the weight of the gear has become apparent. As a motion it leaves little to be desired, and its mechanical advantages are obvious.

"As yet, comparatively little has been done in the improvement of the locomotive in this country in the direction of superior economy and efficiency. In Europe the high price of coal has led to care in design and in operation of locomotives which is unknown here. The French are a generation in advance of us in locomotive operation. In France, locomotive engineers use devices such as double valve gears and variable exhaust nozzles, which we do not intrust to our engineers and firemen. In England, the small number of locomotive failures on the road are a revelation to any one who studies them from our standpoint. In England, the locomotive is given a fair chance by receiving fair treatment, yet it probably does not cost more in the end. We certainly have much to learn from across the water, and while what we may learn is not so much in practice as in method, it is none the less important. That which we most need to learn from England is the value of appreciation of the locomotive and locomotive men. This will be learned and well learned—probably in the near future—of this we may feel sure. We may safely count that when those who are now students are ready to be leaders of mechanical departments of our railroads, the position of the department head will have become an enviable one. There is no field of mechanical work so full of opportunity as this and much depends upon those who are now fitting themselves for the leadership of to-morrow. These leaders may be in the ranks; they may be in the colleges, but wherever they are their preparation must be thorough, for their work is to be great and it will grow to be still greater.

"The idea of the importance of the mechanical problem when demonstrated on a large scale is suggested by the fact that January 1, 1906, a combination of 54 railroads controlled by the Vanderbilt interests became known as 'The New York Central Lines.' All cars, stations, locomotives and all the office stationery used in transacting the business of these 54 roads will bear this name. This enormous combination of responsibilities is not as impressive in any other of its phases as it is in the matter of the motive power responsibilities. The question of design, of construction, of locomotives, of shops and many other questions which are comparatively small on the individual roads of this combination now become great because of the effect of the practice in one portion of the system upon that in another. It is easily understood that such an aggregation of interests renders it necessary to prepare, through careful study, for every change in practice. The design of shops cannot be made without most thorough and careful consideration of practice in other parts of the system, made with the view of adopting the best in every detail, and the same applies with even more force in the case of locomotives. All this points to the necessity for very high authority to properly administrate these responsibilities. In this discussion, only the high points are touched upon, many others being unmentioned because of the lack of time.

"There seems to be no need of arguing at this time in favor of placing full and complete authority for such important problems in the hands of an official who stands immediately next to the throne. This, when done, will mean much to American railroads."

The view which Mr. Basford holds as to the functions of the motive power officer of the modern American railroad agrees closely with that which has been expressed editorially in this magazine more than once for the higher work of the engineer in nearly all departments of his profession. Formerly the highest position to which an engineer, in railroad work, in manufacturing, or in construction, could expect to attain was that of a chief of a department, his duties being confined very generally to the close conduct of actual engineering work. To-day it is becoming evident that the opportunities, possibilities, and ultimate scope of the work of the engineer lead directly to executive and administrative control, and this is true, not only of the motive-power officer but of the responsibile engineer in all large undertakings.

"It is the ship with its bunkers full, its engines tested, its captain forewarned, its straight line voyage charted, that breaks the record into port.

"And it is the minute of talk after the hour of thought, the ounce of effort after the ton of preparation, that steers a business project into the harbor of success."

DEEP MINING IN GREAT BRITAIN.

CONSIDERATIONS UPON THE PROBLEMS INVOLVED IN THE EXPLOITATION OF THE DEEP UNWORKED COAL FIELDS OF GREAT BRITAIN.

George Farmer—Institution of Mining Engineers,

WE have already reviewed in these pages the report of the Royal Commission on British coal supplies, and commented on the fact that this report included only such coal resources as exist at depths not greater than 4,000 feet. Since this limit is distinctly deeper than present workings it has been a matter for consideration as to the difficulties which might have to be encountered in reaching such deposits, and this question forms the subject of a paper by Mr. George Farmer, presented at the recent meeting of the Institution of Mining Engineers.

It is generally admitted that there are serious physical difficulties connected with workings at such depths, these including the effects of crush, and the increase in temperature, to which may be added the problems involved in the use of mechanical appliances, and the general adoption of the long-wall system; and above all, the increased cost.

So far as the question of temperature is concerned, there is no doubt that this is a serious matter. According to the report of the Commission of 1871 it seems probable that the temperature would reach 98 degrees F. at a depth of 3,000 feet. Allowing for the difference between the temperature of the air and the face of the long-wall, it appears that the temperature of the blood would be attained at a depth of about 3,240 feet. The oppressiveness of such a temperature depends to a great extent upon the humidity, but it is believed that at the greater depths the dryness would render the heat more endurable than at shallower workings where more moisture is present.

"It might be thought, perhaps, that an effective ventilation might so keep down down the temperature as to give the ability to work at great depths. The rapidity with which the air takes up heat from the working-faces depends to some extent on the system of working, and this absorption only ceases when complete assimilation of the temperature as to give the ability some cases, under the long-wall system, the air has retained an inferiority of temperature after sweeping past the coal-face. An increased ventilation may be obtained by increasing the ventilating power and the velocity of the air, but only at an excessive cost. Or an increased ventilation may be obtained by making more intake-airways into the coal-face, but here again an excessive cost interferes, while extra airways would certainly afford extra surfaces, from which the air would take up heat. Another suggestion is to make the airways larger than at present. It is not supposed that an increased velocity would either increase or decrease the temperature, for Sir Lindsay Wood has shown the approximation of the temperature of the air to that of the strata through a distance of 10,266 feet; and he found at that distance, that no perceptible difference took place in the temperature of the current when reduced from 41,800 cubic feet to 3,000 cubic feet per minute. It has been found, however, easier to work in velocities of 8.25 feet per second, and the atmosphere at 100 degrees F. than in weak currents with a temperature of 86 degrees

F., especially where the atmosphere is dry. This is explained by the refreshing feeling due to the evaporation of the perspiration on the workman's body.

"Another suggestion worth consideration, perhaps, is the possibility of cooling the air. Water has been tried for this purpose, but the use of water upon shale at a high temperature causes it to swell, and may lead to a prohibitive expense; at the same time, it may render work uncomfortable owing to the combination of moisture with high temperature. Compressed air, passed through condensers, surrounded by cooling jackets, and then conveyed in pipes down the shaft and delivered in the roadways of each district, or delivered near the coal-faces, would certainly assist in cooling the air, and reduce the percentage of moisture, but at what cost? A suggestion worthy of consideration and discussion is the possibility of using liquid air. Its use would be quite safe, whilst it may be applied both to cooling and haulage purposes.

"The coal-dust question will become more serious than at present. Since the prevention of accumulations of layers of fine coal-dust on the supporting timber and sides of the roadways is utterly impossible, and, moreover, its inflammability is increased by the high temperature, it would appear reasonable to adopt some means of rendering the dust a non-supporter of rapid combustion. It will not be wise to use water, which has hitherto been considered to be nature's medicine. It was shown before the Royal Commission on Coal Supplies that dry air was the only sort of air in which miners could work in a deep mine; from the fact that dry air absorbed the perspiration from the men's bodies, whereas if water was used, in the form of spray or otherwise, the air would become saturated to such an extent that effective work would be an impossibility."

So far as the working of seams at such depths as are under consideration is concerned, it appears that the long-wall system is advisable wherever the thickness of the seam will permit. The report of the Commission, however, considers the working of seams as thin as 12 inches, and in such cases it will be found imperative to adopt the universal use of both coal-cutting machinery and coal conveyors.

The high velocities of air currents necessary for adequate ventilation renders it important to consider the question of lighting, and it seems that portable electric lamps might be employed to advantage, especially since they do not abstract oxygen from the air. The probable presence of fire-damp renders it important that some form of detector, such as a diffusion cell on an electric lamp, be used, and it is recommended that one man be made wholly responsible for the safe working of each stall. In regard to danger from explosives, this is a matter which will have to be determined when the condition of such workings with regard to fire-damp is revealed in practice. It seems altogether possible that substitutes for explosives, such as the lime cartridge, may be found available, and remove danger from this source.

The problems of deep winding have already been encountered at length in metal mining, both in Europe and America, as well as in South Africa, and there appears to be no good reason why the experience thus obtained may not be used to advantage in deep colliery pits.

"In summarising the various problems discussed, Mr. Farmer considers that close attention and consideration will be needed to reduce sufficiently the temperature of the mine so as to afford a reasonable amount of comfort to the workmen. This may be done by using compressed air as a motive power in and about the workings, the air being compressed by electric motors near the pit-bottom or on the main intake-airways, so as not to reduce the efficiency. The use of water would be injurious to health, and at the same time ruinous to the adjacent strata.

"Ventilation will be needed to flow at higher velocities, because it is found that men can work in a high temperature with air at a high velocity, better than in the same temperature, or even a lower temperature, at a low velocity. Quicker velocities will lead to improvements in the safety-lamp or in the adoption of the electric hand-lamp.

"Explosives will only be used with extreme caution; and it is quite likely that efficient substitutes for explosives may be found.

"The long-wall method of working, it is

quite likely, will be universally adopted, owing to its adaptability to a simple and adequate ventilation. The coal-faces will be worked forward in a regular line, followed by a regular line of timber, both being conducive to a regular line of break; and for this purpose, coal-cutting machines will be more extensively used. The faces will be set out in long lengths, and the coal will be carried along the faces by means of coal-conveying machinery.

"The main haulage will be carried out by means of electrically-actuated power plant situated at or near the pit-bottom. Machinery may also be used to compress air for use as the motive power of secondary haulage, coal-cutters, coal-conveyors, etc. From this machinery, or other machinery on the same cables, air will be compressed for cooling purposes.

"Careful consideration will be given to the question of spontaneous combustion, in the laying-out of the workings; and the mine must be laid out and worked with the intention of preventing the occurrence of gob fires.

"The shafts and winding appliances will be designed and installed with the view of dealing with a large nett load, in a minimum time of winding. The guides must be rigid, and probably a more extensive use of steel rails will be adopted. In dealing with the load in the shaft, counterbalancing will be found inevitable, but the use of such a counterbalance should not put any extra strain on the capping of the winding-rope. In some cases, a system of dealing with the load at stages in the shaft may be adopted, or some system of winding with the use of tipping-boxes. Where such a system is used, however, it may be found advantageous to use the upcast shaft for winding purposes, on account of the large amount of dust.

"The writer is aware that the cost of fitting an ideal mine might become prohibitive, as the working of seams at depths of 3,000 feet to 4,000 feet would entail the expenditure of much capital in the sinking of wide shafts, and in the laying out and equipment of the surface and underground works; and, to ensure an adequate return, the most rigid economy must be exercised and practised."

CORROSION OF IRON AND STEEL.

CAUSES FOR THE DIFFERENCE IN THE SUSCEPTIBILITY OF IRON AND STEEL TO CORROSION IN MECHANICAL STRUCTURES.

Henry M. Howe—American Society for Testing Materials.

AT the recent meeting of the American Society for Testing Materials there were presented several papers dealing with the problem of the corrosion of iron and steel. Among these was one by Dr. H.M. Howe in which some of the popular opinions as to the relative resistance to corrosion of iron and steel are compared with scientific observations upon the same matter.

Since the general introduction of steel for iron in nearly all departments of construction it has been found that steel is vastly superior in many respects, but there have been maintained certain views as to corrosion which, if true, become very important in some special cases. It is generally believed that wrought iron does not corrode nearly so rapidly as steel, all other things being equal and in locations where resistance to corrosion is essential many engineers will use wrought iron, if it can be obtained. One of the objections to steel pipe is the general belief that it corrodes much more rapidly than wrought iron, while experience seems to confirm the view that iron resists the corrosive action of gases, as in boiler stacks, overhead railroad bridges, etc., far better than steel.

Dr. Howe reviews these opinions in the light of accurate observations, and succeeds in disposing of some of the charges against the behavior of steel, while others are suggested as suitable for further exhaustive scientific investigation.

"On one hand we have the very general public opinion that steel corrodes not only faster but very much faster than wrought-iron, an opinion held so widely and so strongly that it cannot be ignored. Smoke does not prove that fire exists; but such strong smoke bids us look carefully for fire. On the other hand we have the resuts of direct experiments by a great many observers, in different countries and under widely differing conditions; and these results certainly tend to show that this popular belief is completely wrong, and that on the whole there is no very great difference between the corrosion of steel and wrought-iron. Under certain sets of conditions steel seems to rust a little faster than wrought-iron, and under others wrought-iron seems to rust a little faster than steel. Thus taking the tests in unconfined sea water as a whole, wrought-iron does constantly a little better than steel; and its advantage seems to be still greater in the case of boiling sea water. In the few tests in alkaline water wrought-iron seems to have the advantage over steel, whereas in acidulated water steel seems to rust more slowly than wrought-iron."

Dr. Howe calls attention to the fact that with the general introduction of steel into structural work there has been also a great increase in sulphurous acid in the air of cities, while at the same time the presence of stray electric currents in the ground has introduced another cause of corrosion. Hence it is altogether possible that metallic structures may be more subject to corrosion than formerly, and yet this increased corrosion may be due to causes independent of the change in the materials themselves. It is admitted that popular beliefs, while lacking in scientific precision, are generally based upon a larger number of observations than are possible in the laboratory, and a greater variety of conditions of service, and hence they should not be hastily discredited, but given due weight in connection with scientific investigations.

"In view of this great discrepancy between popular belief and the results of our direct taste, it behooves us who have relied chiefly on these latter to examine their conditions carefully, to see whether they really have represented fairly the conditions of actual industrial use and service, in such a way that, if there is a real difference between the corrosion of steel and that of wrought-iron, such a difference would become manifest. In short, have our direct comparative tests been trustworthy?

"Now, when I review our conditions in the light of this apparent contradiction between popular belief and the results of the differences between steel and wrought-iron which ought to cause a difference in their rapidity of rusting, there are three prominent differences: (1) Blowholes; (2) Manganese; and (3) The presence of cementite in the steel and of cinder in the wrought-iron. Let us take these up in order and see how they require that direct tests should be very prolonged or pushed to destruction.

(1) Blowholes exist in steel but not in wrought-iron. But blowholes, at least blowholes which do not weld up and thus cease to exist, are not necessary. Yet they are to be prevented only by care and skill. Hence, get your steel only from careful and trustworthy makers.

(2) Steel always and almost necessarily contains more manganese than wrought-iron. This may or may not hasten its rusting. If it does, then its effects ought to be made manifest even in short-time tests. From the fact that such tests do not show that steel rusts materially faster than wrought-iron, I infer that this manganese is probably not a serious cause of rusting.

(3) Steel is generally richer than wrought-iron in cementite, the iron carbide Fe_3C. Wrought-iron always contains very much more cinder than steel. Each of these substances, the cementite of the steel and the cinder of the wrought iron, may have a double influence on corrosion, hastening it through difference of potential and retarding it by acting as a mechanical barrier like so much paint, to exclude the oxygen or the air or the water. It is not clear that the influence of difference of potential ought to change materially as corrosion proceeds; but it is clear that that mechanical protection given by the plates of cementite and of cinder ought to increase as corrosion proceds. When a piece of wrought-iron, for instance, is first exposed to corrosion, only the outcrops, so to speak, of the sheets of cinder come to the surface; its mechanical protection is very small. But as corrosion proceeds, and more and more of the metal which at first overlay the sheets of cinder is eaten away, the remaining cinder forms a larger and larger proportion of the outer surface, and therefore protects a constantly increasing

proportion of the underlying metal from corrosion. In short, the mechanical protection afforded by the cinder ought to increase as corrosion proceeds. Here, then, is a cause which, as corrosion proceeds, should continuously tend to retard the corrosion of wrought-iron, and to make it compare more and more favorably with steel. But, in like manner, as steel is gradually corroded away, more and more of its surface should come to be composed of cementite, and this fact should tend to retard the corrosion of steel, because cementite, too, should protect the underlying free iron or ferrite.

"These causes may, in time, reverse the initial relative rapidity of rusting of steel and wrought-iron. Steel which in the first few months may rust faster than wrought-iron may, on greatly prolonging the experiments, or pushing them to destruction, actually rust more slowly, and vice versa.

"Now of the two, the cinder of wrought-iron ought to gain more than the cementite of the steel, in its value as a mechanical retarder of corrosion, as time goes on and more and more of the metal is eaten away. The reason for this is that the cementite is in such extremely minute microscopic plate that the eating away of a very small quantity of the iron from above them ought to bring very nearly the full proportion of this cementite to the surface; whereas the much larger and more distantly scattered plates of cinder in wrought-iron would not constitute their full share of the surface until a much thicker layer of initially overlying metal had been eaten away. This, then, may be the true explanation: that is, the reason why steel does not rust faster than wrought-iron in our direct tests, though it does in actual use, is that our direct tests are too short to bring out the full protective action of the cinder of the wrought-iron. Or the reverse may be true. As time goes on, the harmful effect of the difference of potential of the cinder may grow more than its protective action. Let us, therefore, henceforth push our tests to destruction."

THE COURRIERES MINE DISASTER.

A DETAILED ACCOUNT OF THE NATURE AND CONSEQUENCES OF THE FIRE AND EXPLOSION IN THE COURRIERES COLLIERY.

E. Lemaire—Le Génie Civil.

WE have noted already in these reviews the great disaster at the Courrières coal mine, which occurred in March last in the Leus district in the North of France, and as additional technical information is given to the public we shall endeavor to supplement the earlier notes with the later matter.

In recent issues of *Le Génie Civil* there have appeared articles by M. E. Lemaire, describing the general character of the workings of the colliery, the nature of the disaster, and some of the questions relating to the responsibility for the loss.

The mines at Courrières included eleven seams of varying importance, actively worked by nine shafts, the total quantity of coal raised during 1905 being about 2,400,000 tons of semi-bituminous and anthracite coal or about one-fifteenth part of the total production of France, the company employing more than 8,000 miners. The map of the property, given by M. Lemaire, shows the arrangement of the shafts very clearly, while a section gives the general position and depths of the seams, these ranging from about 200 to 400 metres below the surface. The development of the workings in the more important veins is very extensive. Thus the Josephine vein, 2.25 metres in thickness, at 326 metres depth,' contains the best quality of coal on the property, the workings extended for a distance of 3 kilometres, while in other veins workings of 1.5 to 2 kilometres have been made.

Owing to the nature of the coal but little fire damp has been evolved, and until the recent disaster the mines had been comparatively free from trouble of this kind. The system of ventilation had grown up with the development of the property during the past fifty years and while not that which might have been installed had the whole undertaking been arranged at the present time, it appears to have sufficed.

At three of the nine shafts in active operation there were exhaust fans installed, the air descending the other shafts, and being directed through the various workings below by suitable partitions and doors.

Several days before the explosion it was discovered that fire existed in the gob in the Cécile vein, reached by shaft No. 3, this being one of the shafts through which air was admitted to the mine. The arriving air, in the regular course of ventilation, descended to the bottom of the shaft, a depth of 326 metres, and after passing through several workings, including the one in which the fire appeared, it ascended to the 280 metre level, and was returned to the shaft, in which an uptake passage was partitioned off from the main pit, the upward current being produced by means of a small Guibal fan. This fire was promptly dealt with, and walled up to smother it out by depriving it of air, and this work was deemed to have been entirely successful until, on the morning of March 10, an explosion of great violence occurred, the force of the discharge from the mouth of shaft No. 3, being so great as to kill a passing workman by hurling him against a ladder. The shafts immediately connected with No. 3 were pits No. 2 and 4, and at the time of the explosion there were 1,795 miners in the corresponding workings. Of these 550 escaped immediately after the force of the discharge subsided, leaving more than 1,200 below.

The work of rescue has been fully told already, and the immediate efforts of the engineers, supplemented by the invaluable assistance of the Salvage corps, equipped with artificial respirators, from the famous Shamrock Hibernia Mine, in Westphalia, succeeded in effecting the escape of about 100 more men, the final record showing a loss of 1,101 lives.

The latest investigations as to the probable causes of the explosion are given very fully by M. Lemaire. None of the workings involved in the disaster had shown previous evidence of fire damp or excessive dust. So little gas was produced that it was common to permit the use of uncovered lamps in these workings, safety lamps being required only as a matter of precaution at the 380 metre level, where a slight disengagement of gas appeared.

However the fire may have been started, it was at first a simple combustion without any of the elements of an explosion. The walling up of the passages certainly checked its activity, converting its action into a sort of slow distillation, and apparently the resulting combustible gases forced their way through seams in the vein and in the rock, this action being doubtless accelerated by a sudden drop of nearly 2 centimetres in the barometric pressure, thus emphasizing the difference between the internal and external pressure. It is probable that there was a preliminary explosion of the coal gas thus formed in the distilling coal, and that this explosion disengaged large volumes of coal dust which had been lying inert undisturbed. The great explosion, which must have followed almost immediately, was then a dust explosion, one of the most deadly which can occur in mining work.

A simple explosion of fire damp can take place only upon mixture with the proper proportion of air, and the ensuing combustion vitiates only the amount of air required for the combination. The product of the combustion, moreover, is principally carbon dioxide, a gas which is inert rather than poisonous. With a dust explosion, on the contrary, the combustion is almost always incomplete, as is proved by the residue of coke, and the product of the combustion is the extremely poisonous carbon monoxide. The combustion is propagated with extreme rapidity, with all the characteristics of a real explosion, *all* the oxygen in the surrounding air being consumed and replaced wholly with carbon dioxide and especially with the poisonous carbon monoxide.

That the principal explosion was due to dust, and not to gas, is evident by the presence of a fine deposit of coke dust upon the timbering and elsewhere in the damaged workings, so far as they have been inspected. This is one of the important facts bearing upon preventive and protective measures which may be taken hereafter, both in the Courrières mines and elsewhere. It is evidently not enough to assume that the general absence of gas renders a mine safe from disastrous explosion, the dust question must be met and treated in a manner as effectively as has the fire damp danger by the perfection of the modern safety lamp.

The loss to the mining company is doubly great. Until the workings can be restored to their full efficiency, the output of the mines will be reduced by about 500,000 tons per year. In the payment of pensions to the families of the miners killed in the disaster there is involved an amount of nearly a million francs a year. The large number of employees of the company had led the administration to effect its own liability insurance, and the invested funds for this purpose in this case amount to about 14 millions of francs, so that the payments required in consequence of the disaster will absorb more than the income on the entire amount.

M. Lemaire gives an abstract of the French law upon the subject of mining management, which is of local value and interest, and his entire discussion of the affair is altogether judicial, temperate, and scientific.

HOISTING MACHINERY FOR MINES.

COMMERCIAL POSSIBILITIES OF ELECTRIC WINDING MACHINERY FOR SHAFTS AND AUXILIARY MINING WORK.

W. C. Mountain—Institution of Mining Engineers.

WITH the general applications which are being made of electric power to the operation of machinery of all kinds it is natural that the subject of the electrical driving of winding machines in mines should be advocated. Since such machinery is naturally brought into comparison with steam winding engines it is desirable that any examination of the subject should be made upon conditions which are scientifically comparable, otherwise the conclusions are apt to be misleading. In a paper presented by Mr. W. C. Mountain at the recent meeting of the Institution of Mining Engineers the relative value of steam and electric winding is discussed, taking into account the actual operative conditions as deduced from British and German practice and showing the reasons which should influence the choice of system in either case.

"The great mistake which writers on this subject have made in the past is that they only compare the results of electric winding with old-fashioned uneconomical steam engines, but in order to get a true comparison it is necessary to make the comparison on equal lines.

"The advocates of electric winding content themselves, as a rule, by making a statement that the consumption of steam per 'useful horse-power' is anythingfi varying from about 27 to 31 pounds, and they quote the consumption of steam for steam winding engines as from 50 to 150 pounds, (the figure generally approaches the latter), and having done this, they consider that they have satisfied the mining engineer that electric winding is necessarily much more economical. The data given in this paper show how erroneous is this conclusion, because in some collieries the value of the coal burned under the boilers is of such a low grade, and of so little value, that an enormous saving would be necessary to make up for the difference due to the greatly increased cost of the electric plant, and the interest and depreciation which must necessarily be added.

"To those who are not acquainted with the meaning of the words 'useful horse-power,' it might be desirable to explain that this means the theoretical horse-power required to raise a certain quantity of coal during the winding day, assuming that the winding was continuous. It will be clear to all practical mining engineers that such a term is of no practical value, because in shallow pits the number of winds per day is very considerable, and it is well known that the power required to start the load, that is, to accelerate, is very greatly in excess of the average power. In deep pits, it takes no account of the weight of the winding-rope, or the great amount of power necessary to accelerate the large and heavy drums which are required to carry the long length of rope. From many calculations, the writer has found that it is necessary to multiply the 'useful horse-power' by 1.5 for deep shafts, and by as much as 2 for shallow shafts, to get the average horse-power, and to this again must be added the power necessary for the weight of the rope, when the rope is not balanced.

"On the Continent, the success of electric winding is largely due to the use of the Koepe system, which is really an endless rope-wheel, the rim being fitted with hard wood segments, with a turned groove into which the rope fits. Of course, by this system, it is necessary to have a balance-rope, and further, it is not usual to use keps at the pit-head; this makes the banking-out or changing very slow, as the load is brought quietly to rest, otherwise there would be a risk of the rope slipping in the groove. There is a further danger by this system of both cages going to the bottom of the shaft in case of the rope breaking, but this, of course, is a remote contingency and one which appears to be worth very little consideration.

"The advocates of electric winding have also made many claims such as: (*a*) Quicker acceleration; (*b*) greater simplicity; and (*c*) greater safety appliances. The writer feels sure that whilst no doubt electric winding is extremely steady owing to the even turning moment of the motor, with a well-balanced engine winding by steam is perfectly satisfactory, and unquestionably quicker acceleration can be obtained with a steam engine than with an electric motor. The safety appliances which are fitted to an electric winder are fitted on all high-class modern winding engines, and as regards simplicity it is impossible to imagine anything better than a steam engine directly coupled to its winding drums; whereas with the balancer system of electric winding, there are, between the steam engine and the winding drums, the generator, switchboard, cables, motor, flywheel running in two bearings, generator, switchboard, connecting cables, and two motors on the winding gear. This apparatus, if well constructed, should give little or no trouble, but it is foolish to bring forward simplicity as one of the advantages when there are all these links in the chain, and the failure of any one of them would throw the whole gear out of work."

In gathering the data for comparison Mr. Mountain has been careful to select results from a number of large collieries, tabulating the figures very fully, and thus making public the facts upon which his conclusions are based. The costs are computed for the actual cost of winding, and also include provision for interest and depreciation, this being taken at 5 per cent., for interest and 5 per cent. for depreciation, the final resuts being reduced to the cost of winding per 100 tons. The detailed data may be consulted by reference to the original paper, but the general conclusion is that for existing steam plants for large outputs, coal can be wound, including interest and depreciation, at from 5 to 6 shillings per 100 tons.

Similar studies follow for electric winding, considering the data to be the same as to quality, depth of shaft, and time. In the electrical estimates the cost of the primary power-generating plant is taken for an equipment necessary to operate only the winding plant, not including power which might be required for other purposes about the mine. In order to provide against emergency breakdowns, three units of equal size were assumed, with a fair margin of excess over the total power required. Thus, if the size required were 2,000 kilowatts, the plant should consist of three units of 800 kilowatts each, so that the three would run somewhat underloaded and efficiently, while in case of breakdown, two of them could continue without being excessively overloaded. The figures for the electric plants have been based upon actual estimates of the cost of winding plants, providing for slowspeed motor generators and for ample capacity in the proportion of the generating plant and in the boilers to deal with the work, and they are based upon a steam consumption of 25 pounds per kilowatt-hour.

The results of the computations, together with the original data are again carefully tabulated, and the costs work out about double that for high-class steam winding, or about 10 shillings to 12 shillings per 100 tons of coal raised.

Mr. Mountain admits that the conditions to which electric winding are applicable vary so much that each plan should be investigated on its own merits, and his principal contention is that in such investigations the correct data and conditions should be considered. He therefore sets forth the following scheme of data to be used in studying any proposed application of electric power to winding, as necessary if a reliable comparison with steam power is to be obtained. The necessary data are:—

(1) Depth of shaft.

(2) Tons of coal per day.

(3) Time of winding.

(4) Value of coal used under the boilers, and this has greater influence than anything else upon the commercial possibility.

(5) Whether the winding is done from one pit only, or the current is supplied from a central station to a group of pits, and from an electric power company.

(6) If supplied from a power company, the cost at which they will supply current per unit.

(7) The amount of work outside of the winding, which has to be done in the way of pumping, hauling, coal-cutting, surface-driving, etc., in order to ascertain to what extent the load can be levelled, and whether it is necessary to adopt the balancer system or to use three-phase or continuous-current direct.

"It is quite possible (after full consideration of all the above-named points, and particularly if the current can be supplied from a central station to a group of collieries, say, three or four, or more) that the electric energy can be produced at such a low price that it may pay to spend more money on the winding gear and to adopt electricity for every conceivable purpose throughout the pit. Under these circumstances electric winding will have a fair chance, but where heavy winding is to be done at a single colliery and the winding absorbs probably two or three times as much power as the rest of the machinery, and is also only running, say, eight to ten hours per day, there can be no doubt that it is almost impossible to compete with high-class steam engines.

"Another point which is often overlooked in connection with electric winding on the balancer system is that it is necessary to keep the balancer running for practically 24 hours per day, because, after the day's winding is done, the winding engine is used during the night for occasionally lowering down men, timber, etc., and this involves running the large generating plant for 24 hours per day to keep the balancer running. This is necessarily very costly and wasteful, and far more than compensates for the loss in condensation in steam pipes with a steam winder."

GASOLINE RAILWAY MOTOR CARS.

INDEPENDENT MOTOR CARS FOR LOCAL AND SPECIAL SERVICE ON MAIN-LINE STEAM RAILWAYS.

F. W. Hild—Iowa Street and Interurban Railway Association.

WITH the development of the local and interurban electric railway there has naturally come efforts on the part of the steam railroads to meet the cheap and convenient competition which has thus appeared against local railway service. At first the tendency appeared to be a policy of dropping many accommodation trains, permitting the paralleling electric roads to have the local business and refusing to meet the lower fares and more frequent service.

In some places this was followed by a systematic policy on the part of the steam railroads to acquire controlling interests in the various electric lines, using them as feeders to their own stations and generally regulating their operation so as of interfere as little as possible with the main lines, while returning a fair profit on the investment. This has been followed of late by a tendency to imitate European practice by introducing the independent motor car, a self-propelled car, carrying about as many passengers as the ordinary trolley car, and adapted for independent operation on the main-line tracks between regular train schedules, meeting the demand for local passenger service. Such independent cars are designed with various methods of propulsion, some having steam engines and boilers, others being fitted with internal-combustion engines, burning gasoline, much in the same manner as the motors of automobile vehicles, there being almost as many varieties of motive-power machinery as there are builders.

In a paper recently presented before the

Iowa Street and Interurban Railway Association by Mr. F. W. Hild, the subject of the railway motor car is discussed at length, especial comparison being made between the gasoline motor car and what is termed the straight electric system, this latter being the regular electric traction system in which the current is supplied from a stationary power house and delivered to the cars along the route. Mr. Hild is evidently an advocate of the straight electric system, and indeed he plainly states that his paper is a discussion of the subject from the viewpoint of the electric railway engineer, and he gives some interesting facts and figures for use in the study of the question.

"That the large roads have keenly felt the electric railway competition has long been known and it is now particularly evidenced by the various methods under consideration for meeting it. Thus the Union Pacific has built at its Omaha shops a straight gasoline car, wherein the power output of a gasoline engine is mechanically transmitted to the car wheels. The Chicago, Burlington & Quincy some months ago built at its Aurora shops, and for a short time experimentally operated, a gasoline electric car, wherein the power output of the gasoline engine was transmitted electrically to the wheels. The Delaware & Hudson has placed in operation a gasoline electric car built by the General Electric Co. The Lake Shore is also trying such a type of car. The Ohio River & Columbus Ry., according to the technical press, is experimenting with a steam propelled car, which is to be a modern edition of the old time steam dummy. The press very recently described the Strang electric railway car, a gasoline electric car which ran with its own power from Philadelphia, where it was built, to Kansas City, where it is to go into service on an interurban road in that vicinity.

"The writer has seen experimental outfits utilizing the automobile principle of carrying the motive power on the truck frame. In one case it was a high pressure superheated steam engine with direct chain transmission and with flash boiler, kerosene or gasoline pan burner, radiating condenser, etc., all very much the same as the equipment of the well-known "White" steam automobile. In another case it was a four-cylinder gasoline engine, with friction disk transmission, etc., similar to automobile equipment.

"The independent motor car idea had its inception abroad and much more work has been done in this direction in France, Germany and Great Britain than in this country. The most conspicuous application of the idea is the steam motor cars of the Great Western Railway of Great Britain. This railway has in use a number of modernized steam dummy cars using coal as fuel for steam generation. The preference on the continent seems to be for the internal combustion engine and several experimental gasoline engine cars are being tried. The Wurtemberg Street Railway is one of the most aggressive of foreign roads in trying the independent motor car. This railway has experimented with electric storage battery cars, with steam motor cars of the Serpollet type and gasoline cars of the Daimler motor type. It is interesting to note that the Wurtemberg Street Railway put an independent gasoline motor car into service in December, 1893, something over 12 years ago.

"There can be no doubt that most of the several types of self power-contained cars will find useful fields of application and will become valuable auxiliaries to the standard forms of rail transportation; but also, in the judgment of the writer, there should be no doubt that these fields of application will be relatively restricted and do not include such as are now served by the standard electric system."

That electric traction has been brilliantly successful in city urban and interurban service is generally conceded, and any service upon main railway lines which can compete with it successfully must possess the same qualifications of reliability, high speeds and frequency, cleanly and noiseless operation, and low cost of operation and maintenance. These are the features which already characterize straight electric traction, and which should be met by any system intended to meet it in commercial competition. The drawbacks to straight electric traction are obvious, being the necessity for the establishment of large power stations and extensive power transmission circuits, and the consequent very large initial financial investments. The self-propelled car, on the contrary, appeals to the railroad man by the very reason that it, like the steam locomotive, carries its own motive power with it; besides which the initial investment is limited to the car itself, demanding no change or addition to the existing permanent way or equipment.

Assuming the gasoline car as typical of the best designs of self-propelled railway motor car, Mr. Hild proceeds to discuss some of the features of its construction.

"Apparently the greatest difficulty encountered by the designers of the gasoline cars is the transmission of power from the engine to the driving wheel. This is not surprising in view of the fact that the internal combustion engine is essentially a constant speed motor, and that railway work demands wide ranges of variable speeds. At the present time the favorite means appears to be the use of electricity, indicating that the difficulties of direct mechanical transmission and variable speed operation are so great as to warrant the rather roundabout transmission involved by the addition of generator, with or without batteries, and the standard railway type motors and control. Indeed it is claimed by the promoters that the efficiency of the gasoline electric outfits compares very favorably with any type of mechanical transmission and moreover, has the greater advantages of large variations of speed, flexible driving, ease of control, and lesser wear and tear. The acceleration and changes of speed are smooth, and without the jar or shock which is ever present with any mechanical change-speed gear. This situation suggests to electrical engineers the early discussions of series vs. shunt motors for railway work. The designers of the gasoline-electric cars, while fully agreed as to the method of power application, nevertheless differ among themselves on the important question of power supply —thus some insist that a storage battery is an indispensable adjunct, for the reason that gasoline engines have low efficiencies at fractional loads and furthermore have practically no overload margin; the battery, therefore, is needed to take care of the recurring inevitable overloads. Others, however, prefer to use a much larger generating unit, largely because of the saving in weight and space, and the avoidance of acids and fumes."

As already indicated, the subject is discussed by Mr. Hild from the view-point of the electric railway engineer, and hence he advances numerous arguments to show the superior advantages of the latter system. Such arguments are really hardly necessary, since the advantages of complete electric equipment are very generally conceded. The self-propelled car is really intended to fill an intermediate place between the steam-locomotive-drawn train and the complete electric service, and it is upon this basis that it should fairly be considered. As Mr. Hild shows, the maintenance charges for the self-propelled car will doubtless be greater than for the straight electric system. Operating costs, in like manner may be shown to lie somewhere between the straight electric and the steam locomotive service. For the intermediate period of transition, and for the intermittent and special service, however, the self-propelled car appears to have its own proper place, whether propelled by a gasoline motor or by a steam engine, the choice of motive power naturally depending upon local conditions.

"Managers of steam railroads entrusted with the direction of large vested interests, are naturally very conservative and therefore slow to make what would appear to be radical changes in their equipment. Therefore, while they realize the limitations of the steam locomotive in suburban and interurban service, they will, before stringing the trolley wire over their tracks, try out pretty thoroughly the independent motor car, which holds out alluringly the suggestions of interurban service without the power-house, without the track bonding and without the external transmission circuit. This try-out will definitely establish the true field of the self-contained car, and, in the writer's judgment, this field will be the very short spurs of existing steam railroads, serving sparse population, making infrequent trips principally to connect with main lines. Take one road—the Burlington for example; the Galena Junction shuttle train operating on a five-mile spur, and meeting the more important trains of the main line; and the Dubuque shuttle train which operates on the mile and a quarter spur from East Dubuque over the Mississippi River Bridge—these could well use such independent motor cars; unless, indeed, electric power at satisfactory rates can be purchased of the neighboring electric companies.

"There is another field, not very wide it is true, but a profitable field which the independent motor car may enjoy with freedom from competition. The writer expects to see the present private cars of our millionaires displaced by the independent motor car, which can be made as comfortable and luxurious as any of the Pullmans now in service. Their owners may go anywhere that standard gage tracks lead to, regardless of limitations to locomotives or to electric cars.

"As to prospective interurban roads which are promoted with the view to using the gasoline or other types of independent motor, it is highly desirable to go slow and investigate. Broadly speaking, if a prospective road is to depend for revenue only on its passenger and light express traffic, and the business only warrants 1½ or more hours headway between cars, it becomes very much of a question whether or not the road will pay or ought to be built at all.

"But this brings us into the realm of interurban railway economics, concerning which much less even than railway engineering it is not well to generalize. Each individual proposition should be independently examined and passed upon by a competent engineer, who should determine the equipment best fitted for it.

"In conclusion, the writer believes that the independent motor car will prove a useful transportation medium. Its field will be distinct from that served by the standard electric system. The likelihood of the independent motor cars becoming serious competitors of the electric cars is quite remote. Reduction in operating cost of the independent car must come about through cheaper fuel and smaller labor expense. As we all know, the price of gasoline is constantly increasing, due to the diminishing supply of the crude oil from which it is made. Kerosene engines and alcohol engines are frequently spoken of, but as yet can not compete with the gasoline engines. The reduction in labor expense is not very promising. Advances and improvement in the art of motor car construction will undoubtedly be made, but at the same time it must be borne in mind that the electric system will by no means stand still, and if its future progress be judged by that of the past, it will undoubtedly become the pre-eminent transportation medium."

THE ELASTIC LIMIT OF METALS.

THE DETERMINATION OF THE ELASTIC LIMIT OF A METAL BY RECORDING THE VARIATION IN ELECTRICAL RESISTANCE.

M. Guillery—Revue de Métallurgie.

THE determination of the elastic limit of a metal used in construction is admittedly a matter of great importance, and everything which leads to its precise and accurate measurement is to be welcomed.

Briefly, the elastic limit has been defined as that point beyond which strain ceases to be proportional to stress. Such a limit is easier to define than to determine, and in practice none of the methods employed in connection with the commercial testing of materials is wholly satisfactory. When the testing machine is equipped with a reliable recorder the curve rarely shows a distinct point at which the straight line ceases and the rapid curvature of yield begins; and the observer must depend to a certain extent upon his judgment. The determination of the yield point by observing the drop of the beam of the testing machine is a method often used, and with a careful and conscientious experimenter this plan may be employed, but it cannot be said to have claims to scientific accuracy. Some careful observers depend upon their own measurement of the elongation of the test piece by use of dividers, noting the increase in length for successive uniform increases in load, and thus discovering the point at which the elongation begins to increase more rapidly than the stress.

Recently a new method has been proposed, that of recording the variations in the electrical resistance of the test piece as the load in the testing machine is increased, and while this method cannot yet be said to be fully developed, it appears to have possibilities which entitle it to respectful consideration. In a recent issue of the *Revue de Métallurgie* there is given an account of the method by M. Guillery together with the results of a number of tests made by him at Denain. These are also discussed by M. Le Chatelier, in comparison with tests made upon companion test pieces at the laboratory of the *Ponts-et-Chaussées* by M. Mesnager so that it will be seen that the method is in thoroughly competent hands.

The general arrangement of the apparatus is clearly shown by M. Guillery. The test piece is held in the clamps of the testing machine in such a manner that it is insulated by layers of ebonite or fibre. A current of 4 or 5 volts pressure and 25 to 30 amperes per square centimetre of section of test piece, is furnished by a storage battery, this passing partly through the test bar and partly through a compensating resistance. By means of soldered contacts with the extremities of the test bar, a shunt is connected with a Carpentier ballistic galvanometer. Another shunt circuit, taken from the compensating resistance is passed through the galvanometer in the inverse direction, and as this latter may be regulated it is possible to neutralize the deflection due to the first current, and thus bring the reflected ray of light from the galvanometer mirror to zero on the scale at the beginning of the experiment. The subsequent deflections of the galvanometer will then be due to the variations in the electrical resistance of the test piece, and these variations may be recorded photographically, or mechanically. Since the plate upon which the record is made can be moved by a connection with the sliding weight upon the beam of the testing machine, a curve may be traced, which, by suitable calibration will give the stress-strain diagram. M. Guillery examines analytically the relation between the reduction in section and the increase in electrical resistance, showing the nature of the curve, and the fact that the change of curvature at the elastic limit should be clearly defined. A number of reproductions of actual curves indicate that the theoretical considerations are closely reproduced in practice, the change in the direction of curvature being sharply indicated at the point where the strain, or elongation, was no longer directly proportional to the stress or load. It only remains to be assured of the correctness of the calibration to permit the numerical values to be obtained.

A number of test pieces of soft, medium, and hard steel were selected by M. Le Chatelier in duplicate, one set being delivered to M. Guillery at Denain, and the other to M. Mesnager at the testing laboratory of the *Ponts-et-Chaussées,* each series of test pieces having been subjected to similar heat treatment, including tempering, annealing, and raising to a white welding heat. The test diagrams obtained from a number of these specimens are reproduced in the paper and the ultimate resistances, elongations, and elastic limits deduced.

In commenting on these tests, in comparison with those shown by the Mesnager automatic recorder upon the companion test pieces at the *Ponts-et-Chaussées,* M. Le Chatelier notes a constant difference, which he attributes to a difference in the graduation of the two machines. He also rejects certain of the results obtained by M Guillery as having been obtained beyond the proper scale limits of the recording galvanometer, and finds the remaining results fairly comparable.

It has not been fully settled, however, that the increase in the electrical resistance of a test is wholly due to the reduction in cross section, and it is altogether possible that certain chemical changes also occur which may influence the electrical resistance. These and similar points remain for subsequent investigation, and it is altogether possible that certain corrections may need to be made before precise and reliable numerical values may be obtained by the electrical method. The simplicity of the apparatus, however, and its ready applicability to testing machines of various patterns, renders it worthy of notice; and, in the hands of competent scientific investigators it may result in the acquisition of valuable information concerning important materials of construction.

IMPROVEMENTS IN SPACE TELEGRAPHY.

PROGRESS IN THE REGULATION AND DIRECTION OF ELECTRIC WAVE TELEGRAPHY BY THE CONTROL OF PHASE DIFFERENCES.

By Dr. F. Braun—The Electrician.

EVER since the first practical experiments with the transmission of intelligence through space by the means of electric waves, the problem of limiting the reception of communication to selected points has been under investigation. The fact that the waves from the transmitter were emitted in all directions, to be picked up and recorded by any one anywhere who might set up a receiver, seemed to be a material objection to any system of space telegraphy, and the importance of controlling in some way the signals sent out from a given station has been made evident by the untiring efforts of the leading experimenters to accomplish such control.

The first method which naturally suggested itself was to use different wavelengths for different transmitting stations, and efforts were made to devise receivers which should be sensitive to waves of but a single length, failing to respond to messages from any transmitter but the one to which they were tuned. This syntonic method has been carried to a certain practical stage of operation, so that tuned space telegraphy is now an accomplished fact, within certain limitations, while at the same time the efforts which have produced these results have also extended the distances to which messages may be sent. The syntonic method, however, does nothing to prevent the great waste of energy involved in sending waves in all directions, when they are needed in but a single line.

This leads to the second method which has been, and still is under development, that of directing the energy in the direction only in which it is desired that the messages shall be sent, and it is this accomplishment of directed space telegraphy which bids fair to become a most important line of development.

In recent issues of the *Electrician* appear papers by Professor Dr. F. Braun, who has under development important experiments in this line of research, and although the account of his work involves much mathematical study, not available for review in these columns, it may be found practicable to give some general idea of the degree of success which has thus far been attained. The whole subject is also discussed editorially in the *Electrician* in a manner which adds materially to the paper by Dr. Braun, and places the present state of the art clearly upon the record.

It is generally understood that the waves in space telegraphy are emitted from antennæ, or vertical wires erected into the air, and with a single antenna the waves appear to be dispatched in all directions. In the various attempts to direct the waves it has been found that the use of more than one wire gave encouraging results. It was not until the idea of using non-vertical wires was taken up, however, that the true line of investigation was pointed out, and the pioneer work of von Sigsfeld, Strecker, Slaby, and DeForest, as well as the studies of Marconi, led to the gradual development of the method which has been amplified by the work of Dr. Braun.

It is well known that if a source of light is placed at the focus of a parabolic mirror, the rays striking all points of the surface of the mirror will be reflected in lines parallel to the axis of the parabola. This fact, originally due to Huyghens, is the basis of all reflecting projecting apparatus for light waves, and it naturally contains the germ of a suggestion for the direction of electric waves. In attempting to apply this principle to the direction of energy in space telegraphy, DeForest erected a number of equal vertical wires on the arc of a parabola, at the focus of which was the equal vertical sender. This arrangement involved the setting of each vertical wire on the parabolic arc into electrical oscillation, these oscillations being again dispatched from the several wires, causing a proportion of the total radiation to be reflected along the axis of the parabola, in a manner analogous to the reflection of light from a parabolic mirror. The difficulty with this method lay in the fact that the difference in distance of the various wires from the focal sender causes differences of the oscillations on the different wires, both in amplitude and phase.

This difficulty has been overcome by Dr. Braun in a most effective manner by setting up independent oscillations of the proper frequency, amplitude, and phase on each of the wires, this generating plane waves of multiplied vigor travelling along the axis of the parabola.

"The advantages which accrue from the introduction of independent sources of radiation are obvious:—

"(*a*) One is not bound to the parabola form, as in the case of the experiment with electric images. In that case the focal distance must be nearly equal to one-quarter the wave-length, because in the cases which are possible in practice the direct radiation is not negligible compared with the reflected radiation. If one were to work with wave-lengths such as are customary in wireless telegraphy (say, waves of 160 metres length), the aperture of the mirror, measured at the focus, would have to be of the same magnitude. But even a structure of a length of one whole wave would not act in accordance with the laws of geometrical optics. Hence one arrives at dimensions which are unpractically large. On the other hand, the experiments with wave-lengths of 120 metres, which are described below, were carried out with three transmitting wires arranged in a parabola of a total length of 3 metres only.

"(*b*) Obviously, the total radiation from several wires is larger than that from a single transmitter.

"The disadvantages are: Generally speaking, energy is also radiated at the back and the sides of the mirror. The geometrical disposition leads to certain inconveniences in practice and conduces to energy losses.

"Many questions arise which cannot be answered *a priori* but can only be determined by experiment. Among them are: (*a*) If the distance from a source of radiation is only a fraction of a wave-length, one cannot make calculations with the velocity of propagation that the wave assumes at a greater distance. But as this applies to each of the several transmitters, it is to be expected that the effect on the field strength at a very distant point is neutralised just as it is eliminated from the calculations which are based on a constant velocity of propagation at longer distances. (*b*) A wave, due to the action of the other transmitters, is generally superposed on the wave impressed directly on the wire. This superposed wave is out of phase with the wave proper, because the phases in the other wires differ from the phase of the wave in the wire we are considering, and also because of the different intervening distances. These two waves produce a resultant which differs both in amplitude and phase from the impressed wave. Since the waves do not start simultaneously, there must be a complicated oscillation during the starting period, and the stationary condition will only be established gradually."

Dr. Braun gives a mathematical analysis of the manner in which the oscillations are established, taking into account the inductional and damping effects, deriving equations from which the operative conditions may be computed.

"The following is evident, however, without going into the problem mathematically: In coupled systems—which alone are used in practice—the currents in the wires start with small values and increase but gradually. For this reason, the complex initial oscillations in a wire, to which attention was directed above, take place at a time when the action at the far end has not yet attained an appreciable value. Their influence is hardly observed at the phase-measuring apparatus, and the inconvenience can, therefore, be circumvented by measuring and regulating the phase differences after the transmitting wires have been connected up.

"(*c*) So far it has been assumed that there is only one oscillation in each transmitting wire. This, however, only holds good if the coupling is of the loosest. In the actual experiments, there were two oscillations in each wire. The stronger of the two had a wave-length of 120 metres and existed in every wire. It was accompanied by a weaker wave of greater wave-length. But even if each system, oscillating independently, possessed a single oscillation only, the mutual influence of the transmitting wires would introduce a further coupling. This was actually observed when the wires were near one another. For this reason the distances between the wires were kept large.

"(*d*) Such mutual effects are also caused by the leads to the transmitting wires and by the connecting wires—with end capacities—which were relatively near to each other.

"The experiments were made on the following lines:—

"(*a*) To determine, by integrating instruments, the mean field strength at various positions relatively to the air wires.

"(*b*) Assuming these observations to confirm the calculations, to investigate whether the methods are of practical use in connection with the detectors employed in wireless telegraphy. This was necessary because it was thought conceivable that irregularities in the action of the air wires might cause the usual detectors to respond, even if the mean field at the point of observation were nil or very weak.

"In view of the complicated nature of the problem, it was thought best to commence with the simple case of three transmitting wires arranged at the corners of an equilateral triangle. With symmetrical excitation, this also represented the simplest case of the parabola arrangement. A further advantage of this arrangement relates to the possibility of rotating the parabola axis in two steps of 120 deg. each, by interchanging the electric conditions of the air wires. Besides, intermediate directions of the maximum field may be obtained by altering the amplitudes and the phase relations.

Experimental investigations were carried out at Strasburg in accordance with the theoretical deductions, details of which are given at length in the paper of Dr. Braun. The results confirmed in great measure the original conclusions, checking the mathematical computations to a remarkable degree. The experiments included investigations of the field in the case of a fixed phase difference, and in the case of an alteration of the phase difference. The results are tabulated in the paper, and confirm the theoretical deductions, indicating that the directions of the waves may be closely controlled.

STEAM-BOILER PERFORMANCE.

PRINCIPLES INVOLVED IN THE INCREASE OF EFFICIENCY AND OUTPUT OF STEAM BOILERS IN POWER STATIONS.

G. Wilkinson—Municipal Electrical Association.

IN the course of the development of the modern power house many improvements and modifications have been made over the power-generating methods derived from mill and factory practice. Some of these modifications form the subjects of a valuable paper presented before the Incorporated Municipal Electrical Association by Mr. G. Wilkinson, and published in full in the *Electrical Engineer,* and we note especially those relating to the possibilities for improvement in steam-boiler efficiency and output.

Mr. Wilkinson points out that there has been a continual tendency in the engine room to decrease the size of units, while at the same time to increase the output. Thus the use of high-speed engines, and especially of steam turbines, has made it possible to install three or four times the amount of power in a given space than was possible 10 years ago. A similar development has taken place in regard to the electrical machinery, so that many older plants have been replaced by equipments of much greater generating capacity in the same space as that formerly occupied by the lower capacity outfit.

Similar progress has not been made in the steam-generating portion of power-house equipment, however, and Mr. Wilkinson believes that there is room for improvement in the design and operation of the boiler house along the lines which have proved satisfactory and successful in the engine room. Especially if the desirable "unit" system is adopted and maintained is it important that the space, in running feet, occupied by the boilers, should be about the same as that required for the engines and balance of the machinery, otherwise a satisfactory arrangement of floor space, piping, etc., becomes impracticable. This demand has been partially met by placing the boilers in double-deck, one above the other, but this system is expensive to install and inconvenient to operate, besides introducing complications in piping, etc. A more scientific remedy is to increase the size and steaming capacity of the boilers, so that the supply of steam per running foot shall be equal to the demand from the engines occupying the same space.

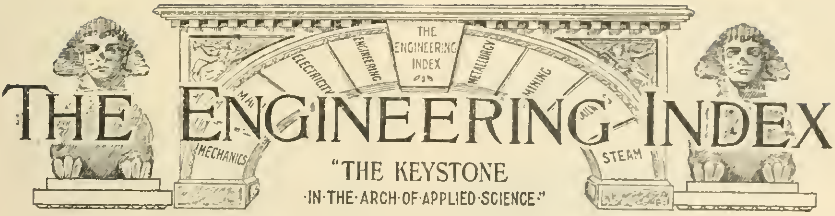
The question is thus resolved into an increase in the rate of transmission of heat from the fuel in the furnace to the water in the boiler, not only as the average demand may be, but as it may be called for by the emergencies of operation. This also includes an efficiency which shall not be lower, and may be higher, than is now attained by boilers operated at a lower steaming rate.

In considering the method by which this desirable result may be accomplished, Mr. Wilkinson calls attention to the fact that the true function of a steam boiler is to make steam, and not to warm water. Since the transmission of heat through the boiler plates is much more rapid at those points where evaporation is actually taking place than in portions at which water is being raised to the temperature of evaporation, it is most important that the feed water be introduced as nearly as possible at the temperature due to the pressure of the steam in the boiler. If the water is thus raised to the actual temperature of evaporation before it enters the boiler at all the whole of the heating surface of the boiler will be converted into actual evaporating surface. Since much more heat is absorbed in the conversion of water into steam than is required to raise the water to the evaporating temperature it follows that the absorption of heat is much more rapid at those portions of the boiler surface where evaporation is taking place than elsewhere, and much more intense firing can be employed without danger of injury to the metal. If, therefore, the whole body of the water in a boiler can be maintained at the temperature of evaporation, the maximum absorption of heat will take place over the entire heating surface, and consequently a maximum intensity of firing may be maintained with efficiency. So far as danger to the heating surfaces is concerned, Mr. Wilkinson shows that the latest scientific researches have demonstrated that no such danger exists, provided the heating surfaces are kept clean and the internal surfaces free from scale and grease. The experiments of Hirsch show that, with sound and clean plates, rates of evaporation up to 75 pounds of water per square foot per hour may be maintained without injury, and this view is confirmed by other investigators. Since present practice shows rates of but 2½ to 7 pounds of water per square foot per hour it is evident that there is here much room for improvement in stationary practice. That higher rates of evaporation are entirely practicable is shown by results obtained in locomotives. Thus at the tests of the Pennsylvania Railroad Company at the St. Louis exposition, total rates as high as 16 pounds per square foot of heating surface per hour were obtained, and much higher rates than this are maintained in the fire-box, experiments on the Northern Railway of France having shown fire-box rates of more than 40 pounds per square foot. Certainly rates of 10 to 20 pounds should be possible in regular practice with suitably designed boilers and accessories.

The question practically settles itself down to methods of heating the feed water to the steam temperature. Mr. Wilkinson believes that this is best obtained by the use of live-steam heaters, and advocates the use of some form of thermal storage, similar to that devised by Mr. Druitt Halpin, possibly improved so as to secure a continuous operation, maintaining a supply of highly heated feed water available at all times.

Mr. Wilkinson discusses the experiments of Anderson, Dales, Hamilton, and others, for which reference must be made to the original paper, but we may here quote the conclusions of Hamilton: viz., that live-steam heaters do save fuel; that economisers show a greater saving than has been accounted for; that evaporating water absorbs heat more rapidly than water which is being only heated; that the rate at which heat passes through a plate depends upon the difference of temperature on the two sides of the plate; and, that evaporation always cools the surface upon which it takes place.

THE ENGINEERING INDEX



"THE KEYSTONE
·IN·THE·ARCH·OF·APPLIED·SCIENCE·"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Arch Construction of the Connecticut Ave. Bridge, Washington. Illustrated description of the method of construction used for the bridge across Rock Creek. 1200 w. Eng Rec—June 2, 1906. No. 77071.

Empirical Formulas for Reinforced Arches. Daniel B. Luten. Discusses a method of empirical design that will enable a designer to lay off all the details of the section for an 80 ft. span in less than an hour's time, yet with great accuracy and efficiency. Ills. 3300 w. Eng Rec—June 28, 1906. No. 77532.

The Bridges over the Iller at Kempten, Allgau, Bavaria (Die Illerbrücken bei Kempten im Allgau). H. Colberg. Describing the construction of two concrete arches of 64.5 metres span, hinged at the crown and spinnings. Illustrations of the centerings and the work in progress are

We supply copies of these articles. See page 799.

given. Three articles, 4000 w. Deutsche Bauzeitung—April 21, 28, May 2, 1906. No. 77662 each B.

Two Austrian Reinforced Concrete Arch Bridges. Gives two illustrations of ribbed arches with open spandrels, with brief descriptions. 500 w. Eng News—June 21, 1906. No. 77410.

Chicago.

A Thirty-three Track Bridge at Chicago. Describes an unusual bridge across 51st St., its constructive details, and careful waterproofing. 1200 w. Eng Rec—June 16, 1906. No. 77337.

Diagram.

A Diagram for Bridge Laterals. O. W. Childs. Gives a diagram designed to enable one to read off the proper size of lateral rod for any panel of any length and roadway within the limits for which the diagram is constructed, explaining its use. 400 w. Eng News—June 21,1906. No. 77414.

Drawbridge.

A Temporary Wooden Drawbridge. Illustrates and describes a bridge built over the Chicago River at Chicago, to carry highway and street railway traffic during the building of permanent bascule bridges. 1200 w. Eng Rec—June 9, 1906. No. 77236.

Newcastle.

The New Railway Bridge at Newcastle. The new high-level bridge of the North-Eastern Ry. Co., over the River Tyne, connecting Gateshead and Newcastle, is illustrated and described. 2500 w. Engr, Lond—May 25, 1906. Serial. 1st part. No. 77147 A.

New York.

The New Manhattan Bridge. W. S. Crandall. Illustrated description of the fourth bridge to be built across the East Island. 1800 w. Munic Eng—June, 1906. No. 77303 C.

Prague.

A Critical Study of the Competitive Designs for a Bridge over the Moldau at Prague (Kritische Betrachtungen über den Wettbewerb für eine Moldaubrücke beim Rudolfinum in Prag). W. Plenkner. With sketches of the seven designs submitted, computations of the stresses, and a comparison of estimated costs. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 19,1906. No. 77620 D.

Quebec.

The Progress of the Quebec Bridge. An illustrated report of the work on this bridge across the St. Lawrence River. 3000 w. Eng Rec—June 23, 1906. No. 77430.

Reinforced Concrete.

The Chauderon-Montbenon Reinforced Concrete Bridge at Lausanne (Die Beton-Eisen Brücke Chauderon-Montbenon in Lausanne). J. Melan. Full details of the high-level viaduct recently constructed at Lausanne, with strain sheets for the arches, and details of the centerings. 5000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—June 1, 1906. No. 77616 D.

Short Spans.

Short-Span Bridges on the Baltimore & Ohio Railroad. Illustrates and describes types of solid floor bridges, in which the loads are chiefly carried by steel beams and girders and the latter are entirely enclosed in concrete integral with the floor slab. 1500 w. Eng Rec—June 16, 1906. No. 77342.

Stresses.

A New Method of Calculating Bridge Stresses by Means of End Shears. W. T. Curtis. Discusses the table of Mr. Gibson in its new form, and commends it as a practical aid in the calculation of stresses in railroad bridges. General discussion. 3000 w. Jour W Soc of Engrs—June, 1906. No. 77506 D.

Viaduct.

The Sixth Street Viaduct at Kansas City. A steel highway viaduct, costing about $2,500,000, is briefly described. Ills. 2000 w. Eng Rec—June 2, 1906. No. 77076.

Viaduct Over the River Barrow Near Waterford. Begins an illustrated description of the largest viaduct in Ireland, its design and construction. 4000 w. Engng—May 25, 1906. Serial. 1st part. No. 77137 A.

CONSTRUCTION.

Beams.

A Floor-Beam Scale in Parallel Co-ordinates. Lucien E. Picolet. Gives a scale for determining the size of steel I beams for floors for any given span and spacing. 1200 w. Eng New—May 31, 1906. No. 77044.

Buildings.

The King's Sanatorium at Midhurst. Describes the engineering features of this recently built sanatorium, built for the special treatment of sufferers from tubercular disease. 1800 w . Engr, Lond—June 15, 1906. No. 77483 A.

The New Soap Factory Building of Armour & Co. at Chicago. Illustrated description, and report of tests of the reinforced concrete floor system of a factory carrying very heavy loads and subjected to the operation of heavy machinery on the upper floors. 2800 w. Eng Rec—June 2, 1906. No. 77075.

Earthquake.

Burnt Clay Construction at San Francisco. Charles H. Alden, Jr. An illustrated account of the condition of materials subjected to the earthquake and fire. 3000 w. Br Build—May, 1906. No. 77180 D.

Earthquakes and Earthquake-Proof Buildings. William F. Scott. Considers the construction of such buildings should be the same as an ocean liner, but as that is impossible, suggests a compromise. 1000 w. Can Archt & Build—May, 1906. No. 77032 C.

Observations of Distant Earthquakes. F. Omori. An explanation of observations made in Tokio, of the San Francisco earthquake, and the determination of the locality and time of the shock. Also editorial. 4000 w. Min & Sci Pr—June 16, 1906. No. 77459.

Our Greatest Earthquakes. Myron Leslie Fuller. Principally an illustrated description of the earthquakes of 1811 and 1812 in the New Madrir region, on the Mississippi River. 4000 w. Pop Sci M—July, 1906. No. 77497 C.

Report of the State Earthquake Commission. Chief part of the report of the Commission appointed to investigate the earthquake which led to the great conflagration at San Francisco. Ills. 3300 w. Min & Sci Pro—June 16, 1906. No. 77460.

Steel Structures in the San Francisco Disaster. George Simpson. A report of the effects of fire, dynamite and earthquake upon the skyscraper. Ills. 6000 w. Ir Age—June 7, 1906. No. 77151.

The Destructive Extent of the San Francisco Earthquake of 1906. Charles Derleth, Jr. Remarks on the evidences of instability of the earth's crust, especially in the San Francisco region, faults, displacements, effects of geological structure, etc., with illustrated description of the destruction wrought at various points by the recent earthquake. 5500 w. Eng News—June 28, 1906. No. 77529.

The Earthquake Explained. A. S. Cooper. Map and explanation of the faults and step-faults of this region. 700 w. Min & Sci Pr—June 16, 1906. No. 77461.

The Effects of Earthquake and Fire on Modern Steel Buildings. Clarence Heller. Personal observations of the San Francisco disaster, and the lessons in building construction there brought out. 3500 w. Engineering Magazine—July, 1906. No. 77684 B.

The Geological Prelude to the San Francisco Earthquake. George H. Ashley. A résumé of the recent geologic history of the San Francisco peninsula and the observed evidence upon which the statement of that history is based. 2000 w. Pop Sci M—July, 1906. No. 77496 C.

The Great Fire in San Francisco. W. G. Mitchell. A report of the effect of the fire upon the buildings, and the material that best withstood the severe trial. 1800 w. Am Archt—June 2, 1906. No. 77083.

The Probable Cause of the San Francisco Earthquake. Frederick L. Ransome. An explanation of the geology of the region and the rock movements causing the earthquake. Map. 1700 w. Min & Sci Pr—June 16, 1906. No. 77458.

The Structural, Municipal and Sanitary Aspects of the Central Californian Catastrophe. Charles Gilman Hyde. An illustrated article presenting a statement of conditions produced by earthquake and fire, and conclusions drawn from them. 3700 w. Eng Rec—June 2, 1906. Serial. 1st part. No. 77069.

Earth Slides.

The Clay Slide at the Boone Viaduct, Boone, Iowa. A. W. Merrick. An account of this slip or slide and the methods of drainage for remedying the trouble. Also a paper by E. E. R. Tratman on "Foreign Railway Construction on Sliding Ground." Ills. 7500 w. Jour W Soc of Engrs—June, 1906. No. 77507 D.

Excavation.

See Civil Engineering, Waterways.

Foundations.

A New System of Foundations (Ueber eine Neue Gründungart). Fritz Hromaka. A description of the Dulac system, in which holes made by a falling pointed ram are filled with concrete. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—May 26, 1906. No. 77621 D.

Mechanical Compression of the Ground in the Construction of Foundations. Emile Guarini. Illustrates and describes a method discussed in a lecture by M. Ducloux, before the Société Belge d'Ingenieurs et Industriels. It consists in compressing the ground by treating it with concrete so as to compress it laterally and depthwise. 2300 w. Sci Am—June 9, 1906. No. 77253.

Reinforced Concrete.

A British Investigation of Reinforced Concrete. Statement issued by a joint committee representing the Royal Inst. of British Archts., the District-Surveyors' Assn., the Inst. of Builders, the Assn. of Munic. & Co. Engrs, and the War Office. 1800 w. Eng Rec—June 16, 1906. No. 77341.

Design of a Long Reinforced Concrete Girder. Frank H. Constant. Description and method of computation employed in the design of two 60 ft. reinforced concrete girders supporting a roof over a ball-room. 3500 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77514 N.

Building Code for Reinforced Concrete. Section 110 from the "Building Code" recommended by the National Board of Fire Underwriters, which gives a standard for concrete construction. 2000 w. Am Archt—June 9, 1906. No. 77179.

"Ferro-Concrete." Sven Bylander. Read before the Soc. of Engrs. An illustrated article considering the best known systems of reinforced-concrete construction, and the methods of approximately ascertaining the stresses. 5500 w. Ir & Coal Trds Rev—May 25, 1906. No. 77149 A.

General Notes on the Theory of Reinforced Concrete Design. R. V. Engstrom. Discusses the interesting phases of this new material, the stresses, the relation of stresses and dimensions, etc. Ills. 2500 w. Technograph—No. 20. No. 77165 D.

Reducing the Cost of Centering and Form in Reinforced Concrete Building Work. Editorial remarks on economical form work. 1400 w. Eng News—June 14, 1906. No. 77439.

Reinforced Concrete and Fireproof Construction in the San Francisco Disaster. Maurice C. Couchot. A report of the condition of these buildings after the earthquake and fire, and suggestions for fireproof construction. 1000 w. Eng News—June 7, 1906. No. 77242.

Reinforced Concrete Bar. A steel bar for reinforced concrete, known as the "Johnson," is illustrated and described, and tests made are reported. Illustrations of practical applications are given. 1600 w. Engr, Lond—June 8, 1906. No. 77391 A.

Reinforced Concrete. Robert A. Cummings. Briefly considers the reasons for steel being embedded in concrete, the materials which compose concrete, the proportions, mixing, etc., methods of erection and applications. General discussion. 10000 w. Pro Ry Club of Pittsburg—Feb., 1906. No. 77292 C.

Roads.

A Road Drag for Improving Earth Roads. Abstract of Bul. No. 1 of the Illinois State Highway Commission, describing the good results and methods of dragging to improve roads, and the simple drags used. 1200 w. Eng News—June 14, 1906. No. 77442.

Laboratory Tests for Road Metals. William R. Hoag. Introductory review of early methods of road construction, and description of machines for determining the comparative value of different materials used in highway construction. 2500 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77512 N.

The Development of the Test for the Cementing Value of Road Material. Allerton S. Cushman. Read before the Am. Soc. for Test. Mat. An account of the attempts made to test the cementing value, and the results. 2000 w. Eng Rec—June 23, 1906. No. 77429.

The Adhesion of Concrete to Steel as Affected by the Quantity of Water Used in Mixing. R. Feret. An account of experiments by the writer, with tabulated results, and notes. 2000 w. Cement—May, 1906. No. 77033 C.

Roofs.

Short Cuts in the Design of Roof Howe Trusses. Benjamin E. Winslow. Gives the results of an investigation to see if it is possible to design a few standard Howe trusses for ordinary flat gravel roofs. Diagrams and tables. 1200 w. Technograph—No. 20. No. 77164 D.

Trusses.

Two-Hinged Arch Trusses for the New Livestock Pavilion, Chicago. Gives sketch plan and diagrams of this new hall for exhibition uses, describing the features of special interest. 1300 w. Eng News—June 28, 1906. No. 77530.

Tunnels.

Driving a Tunnel. An illustrated account of ancient and modern methods of constructing tunnels. 2000 w. Ry & Loc Engng—June, 1906. No. 77101 C.

Handling Spoil from City Tunnel Workings. Illustrated description of a telpher hoist equipment and a new type of quick dumping skip used in connection with tunnel work in New York City. The operation is entirely noiseless, which is of importance as the work goes on night and day in the residence district. 2000 w. Eng Rec—June 16, 1906. No. 77345.

Grade Corrections in the Battery Tunnel, New York. Brief description of the tunnel under construction to connect the subway systems in the Boroughs of Manhattan and Brooklyn, with an explanation of the irregularities and their causes, and a discussion of proposed methods of reconstruction. 2400 w. Eng Rec—June 2, 1906. No. 77070.

Notes on Great Tunnels. Lewis M. Haupt. On the recent development in tunnel construction, giving a brief chronological statement of the statistics and time of construction of the several long railroad tunnels, and other important structures. Ills. 3500 w. Jour Fr Inst—June, 1906. No. 77322 D.

Report on the Defects of the Brooklyn Tunnels of the New York Rapid Transit Ry. Gives the report of George S. Rice. 2500 w. Eng News—May 31, 1906. No. 77043.

Steel Cofferdam for a Hudson River Tunnel Shaft. Illustrates and describes work in connection with the construction of the elevator shaft to the Hudson tunnel between Jersey City and Manhattan. 900 w. Eng Rec—June 2, 1906. No. 77073.

The Construction of the Simplon Tunnel (Der Bau des Simplon tunnels). C. J. Wagner. A general review of the whole Simplon-tunnel project, with a tabular view of the execution of the work, to its completion. 8000 w. Oesterr

Wochenschr f d Oeffent Baudienst—June 2, 1906. No. 77623 D.

The Construction of the Simplon Tunnel (Die Bauarbeiten am Simplon tunnel). Dr. K. Pressel. A very full account of the building of the Simplon tunnel, with topographical map, and detailed plans, sections, and records of the work. Serial. Part I. 2500 w. 1 Plate. Schweiz Bauzeitung—May 26, 1906. No. 77619 B.

The Piercing of the North End of the Karawanka Tunnel (Der Sohlstollenvortrieb bei dem Bau des Karawankentunnels, Nord.) Jos. Fischer. Describing the piercing of the Karawanken mountains by the tunnel to connect Trieste with the interior of Austria-Hungary, including the results of the use of electric rock drills. 4500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—June 9, 1906. No. 77624 D.

The Piercing of the Eastern Alps (Il Traforo delle Alpi Orientali). Emilio Gerli. A discussion of the relative advantages of the Splügen and the Greina routes. Three articles. 7500 w. Monitore Tecnico—April 30, May 10, 20, 1906. No. 77663 each D.

Underpinning.

Underpinning the Criterion Hotel, New York. The reconstruction of this building to adapt it for commercial uses, made necessary some interesting underpinning and heavy shoring, which is illustrated and described. 1200 w. Eng Rec—June 2, 1906. No. 77077.

MATERIALS OF CONSTRUCTION.

Brick.

Tests of the Strength and Fireproof Qualities of Sand-Lime Brick. Ira H. Woolson. Reports a full series of tests made upon 15 varieties of common clay bricks, and a description of the tests applied to sand-lime bricks with the results. 5000 w. Eng News—June 14, 1906. No. 77440.

The Rattling Test as a Safe Method of Disclosing the Permissible Absorption of Paving Brick. Prof. Edward Orton, Jr. Read before the Nat. Brick Mfrs.' Assn. The present number discusses the standing of the rattling, absorption and other tests, reports investigations made, and tests carried out. 3800 w. Brick—June, 1906. Serial. 1st part. No. 77162.

The Strength of Brickwork. Editorial review of the Report on Brickwork Tests, conducted by a committee of the Royal Institute of British Architects. 2500 w. Engng—June 15, 1906. No. 77487 A.

Cement Blocks.

Cement Block Manufacture. S. B. Newberry. From a paper before the Nat. Assn. of Cement Users. Considers the two systems of block making, block machines, their hardening and storage, cost, etc. 2000 w. Munic Engng—June, 1906. No. 77302 C.

Cement.

A New Fine Grinding Machine for Cement Mills. Richard K. Meade. Illustrates and describes a new mill which is giving good results. 2200 w. Eng News—June 21, 1906. No. 77411.

Cement for Building Construction. Report of a special committee of the National Fire Protection Association. Concrete blocks, reinforced concrete, and reinforced concrete beams are considered. 4000 w. Eng Rec—June 9, 1906. No. 77239.

Cement Materials and Industry of the United States. Edwin C. Eckel. Abstract from Bul. U. S. Geol. Survey. Defines the classes of hydraulic cements, discussing the materials and manufacture. 5700 w. Sci Am Sup—June 2, 1906. No. 77047.

Cement on the Farm. E. A. Trego. Remarks on the adaptability of the material to farm needs, describing a model farm on Long Island. 1600 w. Cement Age—June, 1906. No. 77122.

The Decomposition of Cements in Sea Water. H. Le Chatelier. From the Pro. of the Int. Assn. of Test. Mat. A sketch of laboratory experiments made by the writer. 2000 w. Munic Engng—June, 1906. No. 77305 C.

The Formation of Rings in Cement Kilns. Carleton Ellis. Brief discussion of the causes of these aggregations which frequently encrust the internal walls of a rotary cement kiln and prevent the free passage of flames and gases. 1200 w. Eng Rec—June 16, 1906. No. 77343.

Concrete.

Concrete Aggregates. Sanford E. Thompson. Gives the general principles that should be followed in the selection of sand and stone for mortar and concrete, and describes the method of testing aggregates and determining proportions. 4000 w. Cement—May, 1906. No. 77034 C.

Concrete Work in Boston. E. S. Larned. Descriptions of some of the buildings and structures which have recently been completed or are being built. Ills. 5000 w. Cement Age—June, 1906. No. 77121.

Investigation of the Thermal Conductivity of Concrete and the Effect of Heat Upon Its Strength and Elastic Properties. Ira H. Woolson. Read before the Am. Soc. of Test Materials. A record of experiments on the conductivity, strength and elasticity of concrete. 3000 w. Eng News—June 28, 1906. No. 77533.

Some Examples of Concrete Mixing and Delivery Plant. William G. Fargo. Abstract of a paper read before the Mich. Engng. Soc. Illustrates and describes several types of concrete plant suitable for moderately heavy work, treating more especially the handling to and from the mixer. 2500 w. Eng News—May 31, 1906. No. 77041.

The Comparative Resistance to Fire of Stone Concrete and Cinder Concrete. Describes two tests made by the British Fire Prevention Committee demonstrating the superiority of cinder concrete. 1200 w. Eng News—May 31, 1906. No. 77039.

The Early Use of Concrete. Extracts from a paper by Thomas Potter in *The Builders' Jour.* Reviews some very early uses of this material. 3500 w. Am Archt —June 23, 1906. No. 77424.

Gypsum.

Gypsum—A Much Misunderstood Material. Robert Grimshaw. Information of interest concerning gypsum and its use. 1800 w. Sci Am Sup—June 23, 1906. No. 77422.

Piles.

The Manufacture and Use of Concrete Piles. Henry Longcope. Reviews the various methods tried for substituting other material for wooden piles, and the systems for forming concrete piles, and the success attained. 2500 w. Cement—May, 1906. No. 77035 C.

Protective Paints.

Methods of Testing the Protective Power of Paints Used on Metallic Structures. Remarks on rust and the preparations for protecting iron, showing that the durability of a preparation depends on the quality of the linseed oil employed. 700 w. Am Mach—Vol. 29. No. 25. No. 77408.

Timber.

Preservation of Timber. Prof F. H. Bass. Deals with preservation processes, especially considering the creosoting process. Ills. 2000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77511 N.

MEASUREMENT.

Densities.

Use of the Volumetnometer in the Determination of Densities. Floyd R. Watson. Reports an investigation made to test the accuracy of working of the volumetnometer, and to compare it with the Le Chatelier Flask as a means of measuring densities. The substance selected for comparison was Portland cement. 1400 w. Technograph—No. 20. No. 77163 D.

Plotting.

Notes on Plotting Profiles. L. A. Waterbury. A discussion of the methods of constructing profiles and the things that should be shown. 3500 w. Technograph—No. 20. No. 77169 D.

Surveying.

Geodetic and Magnetic Work in the Vicinity of Tananarive (Travaux Géodésiques et Magnétiques aux Environs de Tananarive). Ed Colin. A report on the progress of the official French survey of Madagascar. 1500 w. Comptes Rendus—May 21, 1906. No. 77644 D.

Surveying on the Farm. A. S. Kenyon, in *Jour. of Agri.* (Victoria). Explains the measurement of areas, the prismoidal formula, and other calculations. Diagrams. 4000 w. Sci Am Sup—June 2, 1906. No. 77049.

MUNICIPAL.

Cuba.

Sanitary Conditions in Cuba. Cristino Figuerola Cowan. An illustrated article discussing Havana's great advancement in plumbing and sewerage work. 2000 w. Met Work—June 23, 1906. No. 77425.

Disinfection.

The Municipal Electrolytic Hypochlorite Plant at Poplar. An installation for the purpose of supplying a cheap disinfectant for municipal use, in substitution for disinfectants made from coal tar derivatives, which are slow in action. Ills. 1000 w. Elec Rev, Lond—June 8, 1906. No. 77381 A.

Pavements.

Benefits of Pavements. Ira O. Baker. Read before the Illlinois Clayworkers' Assn. Presents the advantages and disadvantages of pavements, cost, etc. 2000 w. Munic Engng—June, 1906. No. 77304 C.

The Municipal Asphalt Repair Plant at Pittsburg, Pa. Charles Brossmann, Jr. Illustrated description of the plant and its operation. 1200 w. Eng News—May 31, 1906. No. 77038.

Evolution of Street Pavements. George W. Tillson. On the materials formerly, and at present used; the reasons for changes; properties, costs, etc. Ills. 3700 w. Munic Jour & Engr—June 6, 1906. No. 77192.

Washington and Street Paving. An account of the pavements used in the national Capital of the United States, the conditions, average cost and statistics. 2500 w. Munic Jour & Engr—June 6, 1906. No. 77194.

Sewage.

Notes on Sprinkling Filters for Sewage Treatment. George W. Fuller. A résumé of American and foreign experience. 5800 w. Eng Rec—June 23, 1906. No. 77427.

Sewage Disposal at Manchester and Birmingham. Leonard Parker Kinnicutt. An illustrated account of these English plants, one being an example of the contact bed treatment and the other of the percolating filter process. 2500 w. Jour Assn of Engng Soc's—March, 1906. No. 77319 C.

The Intermittent Filtration of Sewage as Practiced in America. Leonard P. Kinnicutt. Address before the Royal Inst. of Public Health, London. Confined to the purification of sewage by intermittent filtration through prepared sand-beds, as practiced in Massachusetts. 3000 w. Jour Worcester Poly Inst—May, 1906. No. 77155 C.

Sewers.

Reinforced Concrete Sewer at South Bend. Sections showing concrete forms and order of erection, with description. 1500 w. Eng Rec—June 16, 1906. No. 77339.

Some Notes on the Los Angeles Outfall Sewer. W. P. Hardesty. Describes the old and the new sewer and explains the troubles with long inverted siphons. 1600 w. Eng News—June 14, 1906. No. 77435.

Streets.

Street Designing. A. Prescott Folwell. Discusses the principles involved, details, width of roadway and sidewalks, requirements of railways, economy, etc. 3500 w. Munic Jour & Engr—June 6, 1906. No. 77193.

Street Traffic.

Some Observations on the Report of the Royal Commission on London Traffic. Paul Waterhouse. Especially considers the proposed formation of new thoroughfares, the difficulties, and possible solutions. Maps. Discussion. 1200 w. Jour Roy Inst of Brit Archts—May 26, 1906. No. 77370 C.

WATER SUPPLY.

Dam.

The Cross River Dam in the Croton Watershed. An illustrated description of an unusual method of construction employed on the New York water-works. 4800 w. Eng Rec—June 16, 1906. No. 77336.

Filtration.

Filtration. J. N. Chester. Discussion of this subject with especial reference to the South Pittsburg Water Co.'s plant. Ills. 3500 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77301 D.

Ground Water.

The Underground Water Supply of the City of Los Angeles, Cal. W. P. Hardesty. Describes some unusual methods employed in the development of the underflow supply. 3000 w. Eng News—May 31, 1906. No. 77037.

Ozone.

Contributors to the Literature of Ozone (Neues aus der Ozonliteratur). A report on the sterilization of water by ozone at Wiesbaden, with a discussion by Dr. Proskauer. 3000 w, 1 plate. Gesundheits-Ingenieur—June 9. 1906. No. 77639 B.

Pure Water.

Life or Death in Pure Country Drinking Water. George Ethelbert Walsh. Shows the dangers found in wells and most water supplies in the country, and considers the best way to secure a safe supply. 2500 w. Archts & Builds' Mag—June, 1906. No. 77178 C.

Sterilization.

Water Sterilization. Dr. Alfred Gradenwitz. Illustrated description of a sterilizing apparatus, showing several types and the variety of applications. 1500 w. Sci Am—June 2, 1906. No. 77051.

Tanks.

The Stresses in the Horizontal Girder of an Elevated Tank. C. E. Day. Gives a study made by the writer of the stresses in a horizontal girder of a tank for a water supply system. 700 w. Eng Rec—June 9, 1906. No. 77238.

WATERWAYS AND HARBORS.

Barcelona.

Extension Works at the Port of Barcelona (Les Agrandissements du Port de Barcelone). François Audion. Describing the extension of the breakwater and the plans for new quays and basins. 3500 w. 1 plate. Génie Civil—May 5, 1906. No. 77610 D.

Canals.

The Sault Ste. Marie Canals. Map and description of the two canals at Sault Ste. Marie. 1800 w. R R Gaz—June 8, 1906. No. 77232.

The Teltow Canal (Der Teltowkanal). Chr. Havestadt. This recently opened waterway connects the Spree with the Havel, passing near Potsdam, Spandau, and Charlottenburg, this rendering it of much commercial importance. Electric traction is used, and details of this, and of the locks and bridges, are given. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—June 2, 9, 1906. No. 77603 each D.

See also Industrial Economy.

Canal Traction.

The Traction Equipment of the Teltow Canal (Die Betriebseinrichtung des Teltowkanals). Erich Block. An exhaustive description of the electric plant designed for the operation of electric traction on the canal connecting the Spree with the Havel. Serial. Part 1. 4000 w. Elektrotech Zeitschr—May 31, 1906. No. 77649 B.

Dock Crane.

A One-Hundred-Ton Derrick Crane for Fitting out Vessels. Illustration, with description, of an interesting crane in use in a Scotch shipyard. 1000 w. Sci Am—June 23, 1906. No. 77420.

Docks.

The Stuyvesant Docks of the Illinois Central R. R. at New Orleans. A modern tidewater freight terminal, occupying a 90-acre site, with a frontage of about a mile on the left bank of the Mississippi River, is illustrated and described. 5000 w. Eng Rec—June 23, 1906. No. 77431.

Jetty.

A New Ferro-Concrete Coal Jetty on the Thames. Illustrates and describes briefly the main features of a jetty being constructed on the Hennebique system. 900 w. Col Guard—June 8, 1906. No. 77385 A.

Lift-Lock.

The Peterborough Lift-Lock of the Trent Valley Canal. Illustrates and describes this lock on the waterway being constructed to join Georgian Bay with Lake Ontario. It is the largest structure of this character in existence and is built almost exclusively of concrete. 1300 w. Sci Am—July 7, 1906. No. 77826.

Nile.

Remarks on Some Old-Time Engineering. T. C. Mendenhall. An interesting popular account of engineering work and conditions in the valley of the Nile. 6000 w. Jour Worcester Poly Inst—May, 1906. No. 77154 C.

Panama.

Extracts from the Minority Report of the Senate Committee on the Type of the Panama Canal. 11800 w. Eng News—June 7, 1906. No. 77243.

The Panama Canal. Projets of the Board of Consulting Engineers. Gen. H. L. Abbot. A demonstration of the marked advantages of the lock type over the sea-level scheme, a view subsequently accepted by Congress. 4000 w. Engineering Magazine—July, 1906. No. 77681 B.

The Disputed Features of the Panama Canal. A letter from Mr. W. Henry Hunter, chief engineer of the Manchester Ship Canal, to the Senate Committee on Interoceanic Canals giving a statement of his views in regard to the dangers of the lock-canal plan. Also editorial. 6800 w. Eng Rec—June 2, 1906. No. 77072. (

Mining Methods for the Culebra Cut. H. M. Chance. A discussion of the applicability of the well-known "milling" system of undercutting by tunnels and shafts, to the economical excavation of the Culebra Cut on the Panama canal. 3000 w. Engineering Magazine—July, 1906. No. 77688 B.

What is Worth While? Editorial discussing the question of a sea-level or lock-canal at Panama, favoring the latter. 2500 w. Eng News—May 31, 1906. No. 77042.

Pier Sheds.

The New Steel Pier Sheds on the East River, New York. Illustrates and describes pier sheds being erected which will be leased for terms of ten years; the improvements and standard design, and the methods of construction are considered. 2000 w. Eng Rec—June 9, 1906. No. 77240.

Port.

New Lake Port. An illustrated account of a new harbor, known as Gary, being developed by the United States Steel Corporation at the extreme southern end of Lake Michigan in Indiana. 2500 w. Marine Rev—June 21, 1906. No. 77448.

River Flow.

See Mechanical Engineering, Hydraulics.

Ship Canals.

The Bruges Ship Canal (Der Brügger Seekanal). W. Kaemmerer. A detailed account of the canal from Bruges to the North Sea at Heyst, now nearly completed . It is 12.75 kilometres in length, with 8 metres depth of water. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1906. No. 77602 D.

The Great Ship Canals of the World. Ambrose G. Grandpre. Brief accounts of ten such canals already built. 2500 w. Technograph—No. 20. No. 77167 D.

Tides.

Pacific Coast Tides and the Determination of Mean Sea Level. W. B. Dawson. Extract from a report entitled "Tide Levels and Datum Planes on the Pacific Coast of Canada," presented before the Canadian Soc. of Civ. Engrs. 1000 w. Eng News—June 28, 1906. No. 77531.

Wharves.

Steel Wharves at Manila. Sections and description of two wharves under construction. Both have platforms of steel beams and girders carrying reinforced concrete floor slabs and supported by rows of small reinforced concrete piers with steel shells and pile foundations. 1000 w. Eng Rec—June 16, 1906. No. 77340.

MISCELLANY.

Reclamation.

Engineering Construction by the United States Reclamation Service. M. O. Leighton. Information concerning the great water-supply installations west of the Mississippi for the purposes of irrigation, which involve an expenditure of over $30,000,000. Ills. Discussion. 5500 w. Jour N Eng W-Wks Assn—June, 1906. No. 77502 F.

Reclaiming the Site of Grant Park, Chicago. An illustrated account of land being reclaimed for a city park in the business district along Lake Michigan. It will require 7,000,000 cu. yds. of filling. About 5,000,000 cu. yds. are already in place. 3700 w. Eng Rec—June 16, 1906. No. 77344.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Modification of the Cable Zero Conductor Resistance Test for Submarine Cables. G. B. Winkfield. Brief description of the proposed method, stating its advantages. 800 w. Elect'n, Lond—May 25, 1906. No. 77129 A.

Exchange.

A New Telephone Trunk Exchange in Birmingham. Describes some of the improvements introduced in this new exchange. One of the most interesting is the use of the telegraph sounder as an aid to the telephone circuits. Ills. 2000 w. Elect'n Lond—June 15, 1906. No. 77479 A.

Space Telegraphy.

On Directed Wireless Telegraphy. Prof. Dr. F. Braun. An account of recent experimental work in this field, which gives promise of a distinct advance. Also editorial. 4200 w. Elect'n, Lond—May 25, 1906. Serial. 1st part. No. 77130 A.

The Commercial Aspect of Wireless Telegraphy. Edwin Edser. A sketch showing the applications made and the successful working of over-sea transmission. 2200 w. Elec Engr, Lond—June 1, 1906. No. 77264 A.

Telegraph Works.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown. Gives the history and general description of the plant, and detailed descriptions of the submarine cable, instruments, batteries, and other products manufactured. Ills. 5500 w. Elec Engr, Lond—May 25, 1906. No. 77125 A.

DISTRIBUTION.

Sub-Station.

Toronto Terminal Station of the Toronto & Niagara Power Company. Illustrates and describes what is said to be the largest sub-station in point of capacity in the world and is to receive 30,000 K. W. at about 60,000 volts from Niagara Falls. 2000 w. Can Elec News—June, 1906. No. 77335.

Supply.

The General Supply of Electricity for Power and Other Purposes: Its Commercial Character and Controlling Management. James N. Shoolbred. Discusses the cause of the backwardness of England in electrical development, offering suggestions for a remedy. Discussion. 6500 w. Jour Soc of Arts—May 25, 1906. No. 77123 A.

Three-Wire.

Resistance Measurements in Three-Wire Systems with Unearthed Middle Wire (Die Bestimmung der Einzelurderstande in Dreileiternetze mit ungeerdetem Mittelleiter). Dr. E. Müllendorff. A discussion of the method of determining the resistance in multiple wire systems by comparing the voltages of the several wires. 1200 w. Elektrotech Zeitschr—May 24, 1906. No. 77648 B.

Transformers.

Transformers with Cooling Ribs (Transformator mit Kühlrippen). F. Niethammer. By the use of thin extended metallic ribs the radiating surfaces are increased, giving opportunity for air-cooling. 1200 w. Elektrotech u Maschinenbau—May 20, 1906. No. 77654 D.

Wiring.

Consumers' Installations. A. E. Woodhouse. Read before the Elec. Assn. of Victoria. Discusses the efficiency and protection from fire and shock in the wiring of buildings. 2200 w. Aust Min Stand—May 16, 1906. Serial. 1st part. No. 77468 B.

ELECTRO-CHEMISTRY.

Batteries.

Arrangement of Battery Cells. George M. Hopkins, in "Experimental Science." An explanation of the method of connecting batteries to secure the greatest efficiency. Diagrams. 1000 w. Sci Am Sup—June 16, 1906. No. 77290.

Bleaching.

Flour Bleaching with the Aid of Electricity. Brief illustrated description of apparatus used in this novel application of electricity. 800 w. Elect'n, Lond—June 8, 1906. No. 77378 A.

Electric Smelting.

Electric Furnace Methods of Iron and Steel Production. John B. C. Kershaw. Introductory review of what has been accomplished in this field, to be followed by articles dealing with the furnaces and processes now used in the electric production of iron and steel. Ills. 1300 w. Ir Trd Rev—June 28, 1906. Serial. 1st part. No. 77516.

Electrical Steel Melting at Disston Plant. Illustrations of the induction type of electric furnace used at this plant, near Philadelphia, which manufactures saws and tools. 1000 w. Ir Age—June 7, 1906. No. 77150.

Some Laboratory Experiments with Electric Furnace. J. W. Evans. An illustrated description of experiments, and of furnaces used. 1200 w. Can Min Rev—June, 1906. No. 77362 B.

Electrode.

A Simple Form of Rotating Electrode for Electrochemical Analysis. F. Mollwo Perkin. Read before the Faraday Soc. Describes a cathode, readily constructed in the laboratory, and gives some results obtained with it. 900 w. Elect'n, Lond—June 15, 1906. No. 77481 A.

Electrotypes.

Rapid Methods for Producing Electrotypes. Sherard Cowper-Coles. An illustrated description of methods for this work used in Europe and America. 1600 w. Elec Rev, Lond—June 15, 1906. Serial. 1st part. No. 77476 A.

Galvanizing.

Cold Galvanizing. Illustrated description of the electrolytic process and apparatus employed by the U. S. Electro-Galvanizing Company. 2500 w. Ir Age—June 21, 1906. No. 77406.

Niagara.

The Niagara Falls Electro-Chemical and Metallurgical Industry. Frank C. Perkins. The first of a series of articles describing the power-plants and distribution. 1000 w. Min Wld—June 2, 1906. Serial. 1st part. No. 77090.

Nitrogen.

Producing Fertilizer from the Atmosphere. William Herbert Hobbs. Describes an industry established about 50 miles north of Rome, Italy, for "fixing" the atmospheric nitrogen in a form suitable for plant food. 1200 w. Min Wld—June 2, 1906. No. 77091.

Zinc.

Electro-Metallurgy of Zinc. Erminio Ferraris. Read before the 6th Int. Cong. of Ap. Chem. Reviews what has been accomplished in the development of the thermo-electric zinc industry. 1200 w. Min Jour—June 16, 1906. No. 77471 A.

ELECTRO-PHYSICS.

Induction.

Induction Between Two Parallel Wires. George D. Shepardson. Explains methods of calculating the induction between parallel wires. 2300 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77510 N.

Iron Losses.

Devices for Determining the Energy Losses in Iron Sheets. Dr. Alfred Gradenwitz. Illustrates and describes testing apparatus of various types for making a magnetic examination of iron. 1000 w. Sci Am Sup—June 23, 1906. No. 77423.

Iron Losses in Alternating Current Commutator Motors (Die Eisenverluste von Wechselstrom-Kommutatormotoren). Dr. Niethammer. A study of hysteresis and eddy-current losses in alternating motors, with formulas and diagrams for practical use. 2000 w. Elektrotechnik und Maschinenbau—June 10, 1906. No. 77657 D.

Magnets.

Alternating-Current Magnets. D. L. Linquist. Gives a brief review of direct-current magnets in order to afford a comparison, and a description of the general features of magnets for alternating current, discussing the general principles of the theory. 2000 w. Elec Wld—June 23, 1906. Serial. 1st part. No. 77465.

Radio-Activity.

The Radio-Activity of Thorium Minerals and Salts. Bertram B. Boltwood. Describes experiments undertaken with the object of determining what proportion of the total *a*-ray activity of radioactive minerals was produced by the thorium present, and whether the activity due to thorium was in all cases proportional to the actual amount of this element contained in the mineral. 4500 w. Am Jour of Sci—June, 1906. No. 77157D.

The Radio-Activity of Thorium. H. M. Dadourian. Read before the Am. Phys. Soc. Describes experiments undertaken to determine the quantitative relation between the thorium activity of various minerals and separated salts, and their content of thorium. 2200 w. Am Jour of Sci—June, 1906. No. 77158 D.

The Radio-Activity of the Salts of Radium. Bertram B. Boltwood. A report of experimental investigations with general results and conclusions. 1800 w. Am Jour of Sci—June, 1906. No. 77156 D.

The Relation Between the Radio-Activity and the Composition of Thorium Compounds. H. N. McCoy and W. H. Ross. A study of compounds and minerals containing thorium; with or without uranium. 3000 w. Am Jour of Sci—June, 1906. No. 77159 D.

GENERATING STATIONS.

Alternators.

Inductor Alternators. E. S. Hawkins. Considers the advantages of the inductor construction, and explains the operating principle. Ills. 1200 w. Engr, U S A—June 1, 1906. No. 77082 C.

Armatures.

Series Parallel Armature Windings with Equipotential Connections. Prof. E. Arnold. The present number considers the design of series parallel windings, the action of equipotential connections, and the particular conditions for equipotential connections with slotted armatures. 3000 w. Elect'n, Lond—June 15, 1906. Serial. 1st part. No. 77478 A.

Brighton.

The Brighton Corporation's New Electricity Works. Detailed illustrated description. 1600 w. Elect'n, Lond—June 15, 1906. Serial. 1st part. No. 77480 A.

Central Stations.

Hot Water, Heat, and Electric Light from a Central Station. Illustrated detailed description of the station at Marion, Ind., and the system of operation. 5000 w. Engr, U S A—June 1, 1906. No. 77080 C.

The Central Power Plant of the Oliver Estate, Pittsburg, Pa. A central plant, in the business part of a city, to furnish light, heat, and power to several large office buildings, and churches, a department store, club, and several smaller consumers. Ills. 1400 w. Eng Rec—June 23, 1906. No. 77432.

Commutation.

Mechanical Aids to Commutation. J. N. Dodd. Aims to define commutation and to explain the purpose and limits of the various devices meant to improve it. 6500 w. Elec Jour—June, 1906. No. 77313.

Construction.

Construction of a Power Plant Under Difficulties. Edward C. Kinney. An account of a plant at Gothenburg, Nebr., and the method of overcoming difficulties with water in digging the pit. 2000 w. Jour Assn of Engng Soc's—March, 1906. No. 77318 C.

Dynamos.

Repairing Dynamo Electric Machinery. Norman G. Meade. Illustrates and describes useful devices and methods. 1200 w. Power—July, 1906. No. 77522 C.

Hydro-Electric.

Hydro-Electric Plant at Albany, Ga. R. W. Hutchinson, Jr. Illustrates and describes a water power development in the south, at the Big Shoals on the Muckafoonee River. 2000 w. Elec Wld—June 16, 1906. No. 77347.

The American Falls Power, Light and Water Company, Limited, the Idaho Consolidated Power Company, and the American Falls Power Company. An illustrated description of the development of these power installations in Idaho. 2500 w. Elec Rev, N. Y.—June 2, 1906. No. 77110.

Madison River Power Company's Plant. G. W. Craven. Describes this river valley in Montana, and describes the plant for utilizing the power. 1700 w. Jour Assn of Engng Soc's—March, 1906. No. 77317 C.

The Hydro-Electric Station on the Sill near Innsbruck (Die Sillwerke bei Innsbruck). J. Riehl and C. Arldt. A very fully illustrated description of the hydraulic and electric features of the plant for supplying the city of Innsbruck with light and power. An average of 13,000 h. p. is developed and transmitted over a distance of 8 kilometres. Three articles. 7500 w. Zeitschr d Ver Deutscher Ing—May 19, 26, June 9, 1906. No. 77600 each D.

The Works of the Mexican Light & Power Co., Ltd. An account of the development of the power of the Necaxa waterfall, 95 miles from the city of Mexico. Ills. 4000 w. Eng Rec—June 9, 1906. No. 77234.

Winnipeg, Manitoba, 60,000-Volt Hydro-Electric Plant. V. D. Moody. Illustrated detailed description of a modern water power plant, which utilizes the water of the Winnipeg River. 3500 w. Elec Wld—June 23, 1906. No. 77464.

Iron Losses.

See Electrical Engineering, Electro Physics.

London.

The Greenwich Electricity Supply Station. Illustrated description of the London County Council's power-station. 3300 w. Engr, Lond—June 1, 1906. No. 77271 A.

Municipal Plant.

Oil-Engine Driven Electric Lighting Plant at Camden, N. J. H. B. Sweet. Illustrated description of a plant of interest on account of the motive power employed. 1200 w. Elec Wld—June 2, 1906. No. 77246.

LIGHTING.

Arc-Lamps.

Improvement in Arc-Lamps. Editorial discussion of several recent improvements introduced in arc-lamps. 2000 w. Engng—May 25, 1906. No. 77144 A.

Assembly Rooms.

Lighting of Public Halls and Lodge Rooms. J. R. Cravath and V. R. Lansingh. Illustrates different arrangements, giving a critical discussion of the methods used. 800 w. Elec Wld—June 2, 1906. No. 77248.

Bridge Lighting.

Electric Lighting of the Passy Bridge at Paris (Eclairage Electrique du Pont de Passy à Paris). E. Bret. Discussing especially the automatic apparatus for lighting and extinguishing the incandescent lamps by which the bridge is lighted. 1200 w. Génie Civil—May 5, 1906. No. 77611 D.

California.

The Edison System of Southern California. R. H. Ballard. Read before the Nat. Elec. Lgt. Assn. An account of this extensive system and its remarkable development. 2800 w. Elec Rev, N Y—June 23, 1906. No. 77443.

Consumption.

The Watt Consumption and Lighting Power of Edison Incandescent Lamps (Ueber Wattverbrauch und Lichtstarke der Edison Glühlampe). R. Lucas. A proof of the law that the illuminating power is proportional to the cube of the consumption of energy. 1000 w. Elektrotech Zeitschr—May 31, 1906. No. 77651 B.

Illumination.

Improvements in the Technology of Illumination (Neues aus der Beleuchtungstechnik). Arthur Libesny. A general discussion before the Vienna Electrotechnical Society, referring to metallic-filament incandescent lamps, also improvements in arc and mercury-vapor lamps. Two articles, 5000 w. Electrotech u Maschinenbau—May 20, 27, 1906. No. 77655 each D.

Some Physiological Factors in Illumination and Photometry. Louis Bell. Abstract of a paper read before the Ill. Engng. Soc. Points out some of the bearings of physiological optics upon practical illumination, its measurement and the limitations of its efficiency. 3000 w. Elec Rev, N Y—June 16, 1906. No. 77308.

Some Points in Illumination. Cole Tay. Discusses the fundamental characteristics of the problem and how to adapt them to the conditions in question. 2300 w. Elec Wld—June 2, 1906. No. 77247.

Lamp Testing.

See Electrical Engineering, Measurement.

Resorts.

Electric Lighting at Summer Resorts on the Atlantic Coast. An illustrated article describing illuminating effects at Coney Island, Atlantic City, Long Branch, and Asbury Park. 7400 w. Elec Wld—June 2, 1906. No. 77245.

Street Lighting.

High Efficiency Incandescent Lamps for Street Lighting. Francis W. Wilcox, Read before the Ill. Engng. Soc., N. Y. Concerning recent improvements in the new high efficiency series lamps, and their advantages for street lighting. 3500 w. Elec Rev, N Y—June 2, 1906. No. 77112.

Street Lighting. C. Turnbull. Briefly considers Nernst lamps and lanterns, suggesting improvements in design. 800 w. Elec Rev, Lond—June 8, 1906. No. 77380 A.

Suggestions for Standard Methods of Arranging and Comparing Street Lighting Methods (Vorschläge zur Einheitlichen Beurteilung und Verfahren zur Berechnung der Strassenbeleuchtung). L. Bloch. A discussion of the best method of arranging street lamps, suggesting a standardizing of practice. 4000 w. Elektrotech Zeitschr—May 24, 1906. No. 77646 B.

Tantalum Lamp.

The Spherical Reduction Factor of Tantalum Lamps. Dr. Clayton H. Sharp. A series of tests showing that the spherical reduction factor of tantalum lamps varies considerably is discussed, and data relating to the variations are given. Ills. 1600 w. Elec Wld—June 16, 1906. No. 77348.

MEASUREMENT.

Lamp Testing.

The Testing of Incandescent Electric Lamps. Preston S. Millar. Remarks on the fallacies of lamp tests, and precautions to be taken to make the tests of value. 2500 w. Elec Wld—June 16, 1906. No. 77349.

Meters.

A New Induction Watt-Hour Meter. G. Faccioli. Illustrated description and study of the meter recently invented by William Stanley. 2300 w. Elec Wld—June 16, 1906. No. 77350.

Electric Meter Testing. Ernest B. True. Suggestions for the proper testing of meters and discussion of methods. Ills. and tables. 5800 w. Technograph—No. 20. No. 77166 D.

Tests and Certificates of the Electric Testing Bureau (Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfamter). A report of the Reichsanstalt illustrating a single-phase induction meter accepted for official calibration. 3000 w. Elektrotech Zeitschr—May 24, 1906. No. 77647 B.

Oscillograph.

An Oscillograph. M. K. Akers. Historical review of the development of this instrument for recording variations of electromotive force or current. Ills. 2000 w. Technograph—No. 20. No. 77168 D.

Resistance.

The Testing of a Low Resistance by Means of Ordinary Laboratory Instruments. G. W. Burley. Describes an attempt made by the author to determine the value of low resistances, when the use of standardized instruments is prohibited. 1800 w. Elec Engr, Lond—June 15, 1906. Serial. 1st part. No. 77473 A.

Standards.

The Board of Trade Electrical Standards Laboratory. Deals with the electrical quantities that can be referred to resistance, current, and electromotive force. Illustrates and describes the laboratory and its work. 5500 w. Engng—May 25, 1906. No. 77139 A.

Testing.

Factory Testing of Electrical Machinery. F. Parkman Coffin. Illustrates and describes the work as carried out by the General Electric Company. 3000 w. Harvard Jour of Engng—June, 1906. Serial. 1st part. No. 77331 D.

Testing for Central Stations. Clayton H. Sharp. Illustrated description of the Electrical Testing Laboratories of New York and their facilities. 3000 w. Cent Sta—June, 1906. No. 77066.

Voltage.

A Simple Method of Measuring Sparking Voltages. E. A. Watson. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Gives a method believed to be new, and its chief feature is the entire elimination of any measuring instruments subjected to the working potential, and the consequent simplification of the high-tension circuit. 1500 w. Elec Engr, Lond—June 15, 1906. Serial. 1st part. No. 77474 A.

MOTORS.

Alternating.

The Alternating Series Motor of the Siemens - Schuckert Works (Wechselstrom-Reihenschlussmotoren der Siemens-Schuckertwerke). Rudolf Richter. A complete description of an improved series alternating motor, comparing it with the repulsion motor. Two articles. 10000 w. Elektrotech Zeitschr—June 7, 14, 1906. No. 77652 each B.

Bearings.

The Inspection of Motors and Motor Bearings. William Kavanagh. Suggestions for determining the clearance between armature and pole pieces, the wear of bearings, etc. 1000 w. Elec Wld—June 2, 1906. No. 77249.

Classification.

The Classification of Alternate-Current Motors. V. A. Fynn. Proposes a classification for these alternate-current commutator machines, which the author believes to have a rational basis. 4800 w. Diagrams. Elect'n, Lond—May 25, 1906. Serial. 1st part. No. 77128 A.

Continuous Current.

Continuous Current Motors. J. W. Burleigh. Gives a short description of a two-pole magnet system and some comparative designs. Diagrams. 1500 w. Elec Rev, Lond—June 8, 1906. No. 77383 A.

Hunting.

Hunting Action of Direct-Current Interpole Motors (Pendelerscheinungen an Gleichstrommaschinen mit Hilfspolen). W. Siebert. Discussing the conditions under which auxiliary poles may produce oscillations. 1200 w. Elektrotech Zeitschr—May 31, 1906. No. 77650 B.

Induction Motors.

The Exciting Current of Induction Motors. A. S. McAllister. Brief outline discussion calling attention to the fact that the value of the wattless component may be ascertained directly from the volume of the air-gap, and the volume of the core material, without reference to the required magnetomotive force, the number or the distribution of the primary coils. 800 w. Elect'n, Lond—June 8, 1906. No. 77379 A.

Interpole.

The Application of the Auxiliary-Pole Type of Motor. J. M. Hipple. An explanation of how a motor of this type makes a saving in the lay-out and operation of the industrial power plant and its distributing system. Diagrams. 1200 w. Elec Jour—June, 1906. No. 77315.

Iron Losses.

See Electrical Engineering, Electro Physics.

Repulsion.

A Modified Repulsion Motor. Gives a modified method of connecting up a repulsion motor, as suggested by F. Punga, in the *Elektrotechnische Zeitschrift.* 1500 w. Elec Rev, Lond—June 8, 1906. No. 77384 A.

Shunt Motors.

A Graphic Method of Determining the Ratio of Speed-Voltage Variation in Shunt Motors. A. E. Kennelly. Shows how the speed-voltage may be determined graphically when the usual data concerning the magnetic and electric circuits are available. 2000 w. Elec Wld—June 23, 1906. No. 77466.

MISCELLANY.

Electricity.

Electricity in the Home. Harold Stannard. An illustrated article describing many applications of electricity to domestic service. 1600 w. Sci Am Sup—June 2, 1906. No. 77048.

Extension.

Extending the Uses of Electricity. H. S. Knowlton. An illustrated article considering its applications to domestic service. 800 w. Cassier's Mag—June, 1906. No. 77294 B.

INDUSTRIAL ECONOMY

Canals.

The Coal Traffic on French Canals. An account of the conditions under which coal cargoes are carried on the canals of France. 4500 w. Ir & Coal Trds Rev—June 8, 1906. No. 77393 A.

Cost Keeping.

Cost Keeping on Public Works. Waldo S. Coulter. Suggestions with remarks on what the reports should show. 1000 w. Eng News—June 14, 1906. No. 77438.

Education.

The Education and Training of Engineers—Civil and Naval. W. H. White. Discusses the report by the Committee of British engineering societies appointed to consider the best method of training all classes of engineers. 9500 w. Nineteenth Century—June, 1906. No. 77298 D.

Exposition.

The Milan International Exposition (Die Internationale Ausstellung in Mailand). With plan of the grounds, and a general account of the arrangement of the Exposition. 1500 w. Stahl u Eisen—June 1, 1906. No. 77632 D.

Japan.

The Economic Future of Japan. Achille Viallate. Discusses the efforts being made to transform the economic system of the country, and the outlook as affecting other nations. 5000 w. Jour Fr Inst—June, 1906. No. 77323 D.

Labor.

The Insurance of Labor in France. Editorial on the action taken to make employers responsible for labor in case of accident or sickness, the State being responsible, should the owner fail. 3000 w. Engng—May 25, 1906. No. 77142 A.

Municipal Ownership.

The Agitation for Municipal Ownership in the United States—Its Origin, Meaning, and Proper Treatment. Everett W. Burdett. Abstract of an address before the Nat. Elec. Lgt. Assn. Shows that public ownership has not produced the results desired, and suggests public control as better. 3500 w. Elec Rev, N. Y.—June 23, 1906. No. 77444.

Patents.

Patent Methods and Industry (Patentwesen und Industrie). Franz Zeis. Showing the relations of an efficient patent law to the development of technical industries with a comparison of the German and Austrian systems. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 8, 1906. No. 77618 D.

Population.

Urban Tendencies of Population as Affecting the Problems of Engineers. Erastus G. Smith. Gives statements showing the tendency toward life in cities, and discusses the causes and effects of concentration of population upon engineering problems. General discussion. 10500 w. Jour W Soc of Engrs—June, 1906. No. 77505 D.

Railways.

The Railways of the World (Die Eisenbahnen der Erde). Condensed statistics of the development of the railways of the earth from 1900 to 1904, with map. 2000 w. Stahl u Eisen—June 1, 1906. No. 77633 D.

Systematizing.

The Need for Systematic Methods in the Conduct of Engineering Works. W. O. Horsnaill. Shows the need of systematic methods. 1000 w. Elec Rev, Lond—June 8, 1906. No. 77382 A.

Typical Factory Systems and Their Practical Results. Egbert P. Watson. A comparison of the older establishments, purely commercial or mechanical in administration, with those including modern welfare methods. 3500 w. Engineering Magazine—July, 1906. No. 77685 B.

MARINE AND NAVAL ENGINEERING

Battleships.

French Dreadnoughts. A discussion of the proposed French battleship-cruiser, giving plans. 1700 w. Engr, Lond—June 1, 1906. No. 77270 A.

New Battleship Designs. Gives inboard profile, deck plans, and description of a powerful Russian design, and also an American design submitted to the Navy Department, comparing the two, and giving data for the guns of various ships. 1200 w. Int Marine Engng—July, 1906. No. 77452 C.

The New Battleship New Jersey, Illustrated description, with report of trial. 800 w. Int Marine Engng—July, 1906. No. 77451 C.

Cargo Steamer.

Lake Cargo Steamer Hoover & Mason, Built With Hopper Type of Hold. Longitudiual and transverse sections with description of a departure in ore-carrier construction, explaining the improvements. 1200 w. Naut Gaz—June 7, 1906. No. 77189.

Engine-Room.

Engine-Room Artificers. Editorial on the position of engine-room artificers in the Royal Navy. 2700 w. Engng—May 25, 1906. No. 77143 A.

Experimental Task.

Experimental Tank at Ann Arbor. Herbert C. Sadler. Illustrates and describes the tank and the method of preparation and testing of ship models. 2500 w. Marine Rev—June 7, 1906. No. 77207.

Fire Boat.

Milwaukee's New Fire Boat. Profile and description of a new steel fire boat of the two-pumps class, equipped with a water tower. 800 w. Marine Rev—June 14, 1906. No. 77306.

Launching.

The Launch of the "Lusitania." Illustrations and interesting account of the launch of the largest and heaviest ship yet floated. 2400 w. Engng—June 8, 1906. No. 77386 A.

Liner.

The Latest and Largest Steamship. Illustrates interesting features of the "Kaiserin Auguste Victoria," of the Hamburg-American line. 1000 w. Sci Am—June 16, 1906. No. 77285.

Mercantile Marine.

Ships and Ports. W. H. Wheeler. Two articles showing what the requirements of the commercial mercantile marine of the future are likely to be, and giving a classification of the ports of Great Britain according to the requirements of trade, aiming to furnish a guide as to the capacity of harbor works, etc. 3500 w. 1st article. Engr, Lond—June 8, 1906. No. 77390 A.

Oil-Tight Work.

Oil-Tight Work in Ships of Light Construction. Herbert Rowell. Read before the Inst. of Nav. Archts. Describes experiments made to ascertain the spacing of rivets necessary to ensure oil-tight seams and connections in ship structures where circumstances rendered the use of thin plates and bars necessary. Records were also taken to show the capability of light structures of this nature to support relatively heavy pressures. Ills. 1600 w. Engng—June 15, 1906. No. 77489 A.

Refrigeration.

See Mechanical Engineering, Heating and Cooling.

Salvage.

A Big Salvage Feat at Liverpool. Illustrates and describes an interesting work in salvage of a steamer beached in sinking condition in the Mersey. 600 w. Marine Rev—June 7, 1906. No. 77206.

Snag Boats.

The Snag Boats of the South. Day Allen Willey. Illustrated description of a boat employed in the St. Louis district for removing these obstacles to navigation. 1400 w. Sci Am—June 9, 1906. No. 77254.

Submarines.

Submarine versus Submersible Boats. Simon Lake. Explains the important differences in these types of underwater boats, and the reasons for some of the accidents that have occurred. Gives diagrams of types and results secured by submersible boats. 4500 w. Engr, Lond—June 29, 1906. No. 77897 A.

The Stability of Submarines. Sir William H. White. Read before the Royal Society. A record of the results of calculations made to determine the conditions of stability of submarine vessels in varying circumstances which may occur in service. 3000 w. Engng—May 25, 1906. No. 77145 A.

The Two Modern Types of Submarines. E. L. Warren. An explanation of the methods in use to maintain neutral equilibrium as exemplified in the Holland and Lake types. 2000 w. Yale Sci M—June, 1906. No. 77372 C.

Torpedo Boats.

Armorclads and Waterclads. Gives detail plans and description of a 20-knot 140-ft. seagoing subsurface torpedo boat, and presents its advantages as compared with the submarines. 2800 w. Marine Rev—June 7, 1906. No. 77205.

Tow Boat.

Paddle Tow Boat Kaiser Wilhelm II (Radschleppdampfer Kaiser Wilhelm II). O. Heesch. Detailed description of a powerful paddle towing steamer for service on the Elbe with illustrations of hull and engines. 1200 w. 1 plate. Schiffbau—May 23, 1906. No. 77658 D.

Turbine Steamers.

The Cunard Liner "Lusitania." Editorial discussion of this recently launched British vessel, which marks a distinct advance in size, speed and method of propulsion. 3300 w. Engng—June 1, 1906. No. 77269 A.

The Cunard Liner Lusitania. With illustrations of the hull before launching and a view of the stern showing rudder and one of the propellers. Data concerning the powering and the general equipment of the vessel are also given, including electric lighting, telephones, etc. 1800 w. Sci Am Sup—June 30, 1906. No. 77710.

The Dover-Ostend Turbine Steamship "Princesse Elisabeth." Illustrations, description and report of trials. 1500 w. Bul Int Ry Cong—May, 1906. No. 77508 E.

Two New Turbine Steamers. Illustrates the "Kingfisher" and the "Duchess of Argyll," giving short description. 400 w. Engr, Lond—May 25, 1906. No. 77148 A.

The Present Status of the Turbine as Applied to Marine Work. Herbert C. Sadler. Discusses the requirements in marine propelling instruments and considers the suitability of the steam turbine to meet the conditions. 4500 w. Jour Assn of Engng Soc's—March, 1906. No. 77316 C.

Wrecking the George W. Elder. An interesting illustrated account of a very difficult but successful raising of this steamer which sank in the Columbia river, Oregon. 1500 w. Marine Rev—June 28, 1906. No. 77740.

MECHANICAL ENGINEERING

AUTOMOBILES.

Adams-Hewitt.

The 10-H. P. Adams-Hewitt Light Car. Illustrated description of a powerful but low-priced car having many features of interest. 1000 w. Autocar—May 26, 1906. Serial. 1st part. No. 77124 A.

Automobile Shops.

Where an Air-Cooled Car is Built. Illustrated description of the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y. 1300 w. Automobile—June 21, 1906. No. 77450.

Bearings.

Ball Bearings—Good, Bad, and Indifferent. Henry Hess. Read before the Soc. of Auto. Engrs. in New York. Discusses the principle upon which the ball bearing is built, the friction, destructive wear, causes, and remedies. 3000 w. Automobile—May 31, 1906. No. 77061.

Cooling.

Air-Cooling Systems for Motors. An illustrated article describing methods of air-cooling used in America, and discussing the construction of types of air-cooled cylinders. 1500 w. Automobile—June 21, 1906. No. 77449.

Water-Cooling Systems for Motors. Explains reasons for the cooling process and gives brief illustrated descriptions of several systems. 1500 w. Automobile—June 14, 1906. No. 77275.

Coventry Humber.

The 10 12-H. P. Coventry Humber Car. Illustrated description of the general arrangement, engines, rear axle, and control. 1600 w. Autocar—June 9, 1906. No. 77375 A.

Daimler.

The New 45-H. P. Daimler Car. Illustrated description of the latest car of this company, which shows a number of departures from previous cars of this make. 2000 w. Autocar—June 2, 1906. No. 77258 A.

Fittings.

Equipment for a Touring Car. The present number deals with articles that experience has shown to be desirable in the full equipment of a car for daily use about town. 2500 w. Automobile—June 28, 1906. Serial. 1st part. No. 77535.

Gasoline Car.

The Gasoline Car for Interurban Service. Extracts from a paper by F. W. Hild, read before the Iowa St. & Int. Ry. Assn. A review of the railway motor car and its capabilities; confined to internal combustion engines using gasoline as fuel. 3800 w. Ry & Engng Rev—June 2, 1906. No. 77087.

The Gasolene Car for Interurban Service. Extracts from a paper by F. W. Hild, read before the Iowa St. & Inter. Ry. Assn. Refers to various types of independent motor cars tried, and considers especially these cars as compared with the electric system. Concludes that they will prove useful in a field quite distinct from the standard electric system. 4800 w. R R Gaz—June 1, 1906. No. 77055.

Ignition.

A New Low-Tension Magneto. Illustrated description of the new system of ignition of the Albion Co. 1200 w. Autocar—June 9, 1906. No. 77374 A.

Ignition Devices for Automobile Motors (Die Zündvorrichtungen der Automobilmotoren). E. Konig. Discussing especially electrical ignition appliances, methods of timing the spark, comparing the advantages of the battery and the magneto. Two articles, 5000 w. Elektrotech & Polytech Rundschau—April 20, 27, 1906. No. 77659 each D.

The Ignition Timer and Its Functions. An illustrated description of the timer and its function. 1500 w. Automobile—May 31, 1906. No. 77062.

Iris.

The Latest 25-30 H. P. Iris Cars. Praise for the Iris cars with illustrated description of alterations made in the design. 600 w. Auto Jour—June 16, 1906. No. 77470 A.

Materials.

Materials for Automobile Construction. Thomas J. Fay. From a paper read before the Soc. of Auto. Engrs. in N. Y. Information on requirements for materials needed for various parts of automobiles. 2800 w. Automobile—June 28, 1906. No. 77534.

Motor.

Four-Cylinder Motorcycle Engine (Viercylinder-Fahrradmotor). Bruno Müller. Detailed illustrations of 3 horsepower four-cylinder motor for motor cycles, built at the National Firearms Works at Herstal, Belgium. 2000 w. Elektrotech u Polytech Rundschau—May 30, 1906. No. 77661 D.

Omnibuses.

Public Service Motor Vehicles. W. Worby Beaumont. General descriptive remarks on the progress made in the development of the motor omnibus, illustrating and describing types. 3000 w. Tram & Ry Wld—June 7, 1906. Serial. 1st part. No. 77403 B.

Rochet-Schneider.

The Rochet-Schneider Cars. Illustrated description of these cars which are made in several sizes. 900 w. Auto Jour—June 9, 1906. No. 77376 A.

Steam.

The Steam Plant of the White Motor Car. R. C. Carpenter. Considers in detail this system, which is at present only applied to propulsion of motor cars, showing the economic results obtained by the use of steam of high pressure and high temperature. Ills. 3000 w. Sib Jour of Engng—June, 1906. No. 77324 C.

The Weyher and Richemond Steam Automobile (Automobile à Vapeur des Etablissements Weyher et Richemond). F. Drouin. Illustrated description of an 18 h. p. steam machine with flash boiler, engines, and chassis. 1500 w. Génie Civil—May 12, 1906. No. 77612 D.

COMBUSTION MOTORS.

Alcohol.

The Industrial Uses and Value of Alcohol. Henry Hale. Mentions ways in which grain alcohol will take the place of other fluid when the tax upon it is removed, and discusses its importance as a producer of light, heat and power. 1700 w. Sci Am—June 23, 1906. Serial. 1st part. No. 77417.

The Use of Alcohol as a Fuel for Gas Engines. H. Diederichs. Considers the fuel value and the physical properties of alcohol, and the details of the alcohol engine, whenever they differ from the gasoline or crude oil machine. The efficieny and cost are also briefly discussed. Ills. 5000 w. Int Marine Engng—July, 1906. No. 77454 C.

Engines.

Phenomena of the Working Fluid in Internal-Combustion Engines. Extracts from a paper by Dugald Clerk, at meeting of the Royal Society. An investigation of the specific heat of, heat-flow from, and other phenomena of the working fluid in the cylinder of the internal combustion engine. 2800 w. Jour Gaz Lgt—May 22, 1906. No. 77065 A.

Gas Engines.

Notes on Gas Engines (Ueber Gasmaschine). Alfred Menzel. A general review of gas power generation, including gas producers, engine details, regulation and operation. Three articles. 8000 w. Elektrotech u Maschinenbau—May 27, June 3, 10, 1906. No. 77656 each D.

Rational Methods of Gas-Engine Powering. Sanford A. Moss. Gives general principles for obtaining approximate results, and rational formulas for exact results if actual coefficients, etc., are known. Only four-stroke-cycle stationary engines are considered. 3000 w. Power—July, 1906. No. 77521 C.

Gaseous Mixtures.

The Explosion of Gaseous Mixtures, and the Specific Heat of the Products. B. Hopkinson. A report of experimental investigations, comparing the results with the work of other investigators. 3300 w. Engng—June 15, 1906. No. 77485 A.

Gasoline Motors.

Some Recent Interesting Industrial Applications of the Gasoline Motor. An illustrated article describing unusual applications. A motor-driven sewage-collecting wagon; a wagon for trolley inspection; air compressor motor, etc. 2700 w. Sci Am Sup—June 16, 1906. No. 77288.

The 30-35-H. P. Simms Petrol Engine. Brief illustrated description of an engine designed for heavy commercial vehicles, such as omnibuses. 400 w. Auto Jour—June 2, 1906. No. 77259 A.

Gas Power.

Gas Power. Oskar Nagel. Explains the causes of the progress of the gas engine industry. 2000 w. Elec Chem & Met Ind—June, 1906. No. 77250 C.

Igniters.

Experiments on Gas Engine Igniters. F. W. Springer. Illustrates and describes experiments used in an experimental study of ignition apparatus commonly used in gas engines. 3800 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77515 N.

Oil Engines.

The Effect of Water Injection on Crude-Oil Engines. Robert F. McKay. Discusses the advantages and disadvantages of water injection. 1000 w. Engng—May 25, 1906. No. 77140 A.

Producer Gas.

Producer Gas and Gas Producers. Samuel S. Wyer. Read before the Illinois Clay-Workers' Assn. Considers the constituents of producer gas and gives illustrated descriptions of types of gas producers. 1600 w. Brick—June 1, 1906. No. 77161.

Producer Gas Power. Julius Wile. Considers reasons for the popularity of producer gas, its efficiency, etc. Ills. 1000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77513 N.

Starting.

On Some Methods for Starting Explosion Engines. E. Butler. Briefly describes eight methods used and describes experiments made by the writer, giving diagrams. 4000 w. Mech Engr—June 2, 1906. Serial. 1st part. No. 77262 A.

Suction Gas.

Suction Gas Producers. Oskar Nagel. An explanation of this system of gas-producer plants. 1200 w. Eng & Min Jour—June 9, 1906. No. 77196.

Suction Gas Producer Trials. The first of a series of articles giving an account of the trials of suction gas plants at the Royal Agricultural Society's Show.

Ills. 1600 w. Engr, Lond—June 15, 1906. Serial. 1st part. No. 77482 A.

HEATING AND COOLING.

Atmospheric Regulation.

Artificial Regulation of Atmospheric Humidity and Temperature. Illustrated description of a machine designed to regulate artificially the ratio between the temperature and the humidity by passing water over a large cooling surface, over which, at the same time, large volumes of air are being drawn. 2000 w. Sci Am—June 23, 1906. No. 77418.

Central Plant.

A Central Steam Heating and Power Plant. W. N. Zurfluh. Illustrated description of the plant in Springfield, Ohio. 3000 w. Engr, U S A—June 15, 1906. No. 77368 C.

Hospital.

Heating and Ventilating a Hospital. Illustrated description of the combination of direct and indirect steam heating installed in St. Luke's Hospital, Utica, N. Y. 2000 w. Met Work—June 2, 1906. No. 77063.

Hot Water.

Computations for Hot Water Heating (Berechnung von Heisswasserheizungen). A. Goebel. With very complete tables and diagrams for determining the proportions of a hot-water system for a required heating capacity. 7500 w. Gesundheits-Ingenieur—June 2, 1906. No. 77638 B.

Construction and Application of the Brückner Heating System (Die Konstruktiven Grundlagen und die Praktische Augestaltung der Brücknerheizung). W. Brückner. Describing a hot-water heating system in which the circulation is accelerated by the action of steam in the main riser. 3500 w. Gesundheits-Ingenieur—June 2, 1906. No. 77636 B.

The Determination of the Emission of Heat from Hot-Water Apparatus (Zur Regelung der Warmeabgabe bei Warmwasserheizung). G. de Grahl. With curves and tables derived from the formula of Rietschel for computing the emission of heat from radiators for various temperature differences. 2000 w. Gesundheits Ingenieur—May 19, 1906. No. 77634 B.

The Theory of the Accelerated Circulation System of Hot-Water Heating (Zur Theorie des Schnellumlauf-Warmwasserheizung). Dr. Fritz Hasenöhrl. An examination of the action of steam in the main riser in accelerating the circulation in a hot-water heating system. 3000 w. Gesundheits-Ingenieur—June 2, 1906. No. 77637 B.

Post Office.

Heating and Ventilating Plant of the Indianapolis Post Office and Custom House. Plans and description of a plant for a 4-story building built upon three sides of a hollow square, and occupying an entire city block. Both direct and indirect radiation are used. 5200 w. Eng Rec—June 9, 1906. No. 77235.

Refrigeration.

Management of an Absorption System. W. S. Luckenbach. Suggestions for difficulties that may arise, and for the operation of the plant. 1500 w. Engr, U S A—June 15, 1906. No. 77369 C.

Cold Storage on Board Ship. Sydney F. Walker. The first of a series of articles discussing the problems in connection with cold storage on ships. Ills. 3500 w. Int Marine Engr—July, 1906. Serial. 1st part. No. 77453 C.

Speed of Ammonia Compressors. R. L. Shipman. Some observations in regard to results of high speed of ammonia compressors, a report of tests made, and conclusions. Ills. 4000 w. Ice & Refrig—June, 1906. No. 77100 C.

Schools.

Comparison of Heating and Ventilating Plants Installed in Chicago Public School Buildings at Various Periods. An analysis of the cost of installation, fuel consumption, maintenance and efficiency. 1200 w. Eng & Min Jour—June 16, 1906. No. 77346.

Heating and Ventilating a Modern School Building. C. Dix McArthur. Describes a school of medium size, No. 42, the Bronx, New York City, which presents a good example of a high pressure system; ventilating by steam engine driven blowers and heating with exhaust steam. Ills. 1800 w. Dom Engng —June 16, 1906. No. 77334.

Heating a School Building by a Warm Air Furnace. Plans and explanation, submitted by T. J. Grier for a design to meet the requirements of compulsory ventilation. Ills. 2000 w. Met Work—June 9, 1906. No. 77160.

Steam Heating.

The Flow of Steam through Regulating Valves in Low-Pressure Steam-Heating Plants (Ueber den Dampfdurchgang durch Regulierventile in Niederdruckdampfheizungen). H. Zyka. Applying the formula of Gutermuth to the regulation of low-pressure steam heating, with tables and diagrams. 7500 w. 3 plates. Gesundheits-Ingenieur—May 26, 1906. No. 77635 B.

Steam.

Modified Systems in Steam Heating. The present article illustrates and describes the Webster vacuum heating system. 1000 w. Met Work—June 2, 1906. Serial. 1st part. No. 77064.

Ventilation.

Notes on the Theory of Disc Ventilating Fans (Beitrag zur Theorie der Schrauben Ventilatoren). C. F. Holmboe. Discussing the best shape of blades, deliveries of air for various speeds, and general proportions of ventilating disc fans. 2500 w. Zeitschr d Ver Deutscher Ing—June 9, 1906. No. 77605 D.

Working Out a Ventilating System for a Telephone Exchange. Louis Rosenberg. Illustrated description of the plant designed for the operating room of the Cuyahoga Telephone Co. 2500 w. Heat & Vent Mag—June, 1906. No. 77501.

HYDRAULICS.

Flow.

Researches for the Determination of a Formula for the Flow of Water over Natural River Beds (Versuch der Aufstellung einer Geschwindigkeitsformel für Naturliche Flussbette). R. Siedek. A review of the previous paper of Dr. Max Matakiewicz, comparing his results and the author's with actual measurements. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—May 26, 1906. No. 77622 D.

The Friction of Flowing Water in Pipes (Strömung Reiben der Flussigkeiten in Rohrleitungen). L. J. Bodaszewski. A review of the formulas of Helmholtz, Neumann and others, with tables computed for the constants under various conditions. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—May 25, 1906. No. 77615 D.

Oil Pumping.

Rifled Pipe for Pumping Heavy Crude Fuel Oil. John H. Isaacs. Explains the troubles encountered in trying to pipe this oil, and the results obtained with rifled pipe. Describes the rifling machine used, giving illustrations. 2000 w. R R Gaz—June 8, 1906. No. 77233.

Pumps.

High-Lift Turbine Pumps. Their Design and Efficiency. R. J. Durley. A study of the principles which have been applied to extend both the efficiency and the capacity of the centrifugal pump, with examples of service applications. 4500 w. Engineering Magazine—July, 1906. No. 77683 B.

MACHINE WORKS AND FOUNDRIES.

Bells.

The Bell Industry. Storrs Ely Emmons. Brief illustrated account of the factories at East Hampton, Conn., and their history. 1000 w. Mach, N Y—June, 1906. No. 77098 C.

Boiler Making.

Laying Out a Plain Cylindrical Boiler. George Guntz. Directions, with diagrams. 1200 w. Boiler Maker—June, 1906. No. 77251.

Boring.

A Corliss Cylinder Boring Machine. Illustrated description of a machine designed for simultaneously machining the bore, valve chambers and flanges of Corliss cylinders up to 36 inches bore by 8 ft. long. 500 w. Am Mach—Vol. 29. No. 212 No. 77057.

Brazed Joints.

The Strength of Brazed Joints in Steel Wire. Henry Louis. Read before the British Inst. of Min. Engrs. Reports tests made to determine whether it is possible to produce a brazed joint equal in strength to the original wire. 1200 w. Ir & Coal Trds Rev—June 15, 1906. No. 77493 A.

Cast Iron.

Cast-Iron in the Foundry. Abstract of a paper by P. Longmuir, read before the W. of Scotland Ir. & St. Inst. Discusses the composition, treatment, etc., to produce the best castings. 2500 w. Mech Engr—June 2, 1906. No. 77263 A.

Malleable Cast Iron, Its Manufacture and Its Physical Properties. G. A. Akerlind. Read at meeting of the Scandinavian Tech. Soc. A discussion of the manufacture and properties of this material. 4000 w. R R Gaz—June 8, 1906. No. 77231.

Cores.

Core Sands and Core Binders. E. D. Frohman. Read before the Cleveland Foundry Foremen. Discusses the question of sands and of core compounds, giving a report of tests and showing that the amount of loam in the sand determines what core binder must be used. 2000 w. Foundry—June, 1906. No. 77320.

Multiple Core Molding. H. J. McCaslin. Describes this method of core making, which is especially adapted to small castings. Ills. 1500 w. Foundry—June, 1906. No. 77321.

Corrosion.

Oil Corrosion in Cylinders. Harry Spurrier. An account of the writer's experience and the remedy applied. 1200 w. Power—July, 1906. No. 77519 C.

Cranes.

The Electric Crane in the Foundry. Harry Sawyer. Read at Cleveland meeting of the Am. Found. Assn. Remarks on the requirements of these cranes, the conditions under which they are operated, high speeds, control, etc. 2000 w. Ir Trd Rev—June 14, 1906. No. 77274.

Dies.

Making a Blanking Die. C. F. Emerson. Names the essential things to be considered in making blanking dies, and the method of making them. Ills. 1200 w. Mach, N Y—June, 1906. No. 77099 C.

Drafting Rooms.

A Drafting Office System. A. Jacobs. Explains a system which it is believed may be used as a basis for a system to meet any requirements. 2000 w. Am Mach—Vol. 29. No. 26. No. 77527.

Draftsmen.

The Question of Men and Salaries in the Drafting Room. George F. Summers.

A statement of existing conditions, considering the value of a draftsman, the pay, etc. 1400 w. Am Mach—Vol. 29. No. 22. No. 77059.

Electric Driving.

Electric Power Transmission. E. J. Erskine. Read before the Engng. Assn. of N. S. W. On the advantages to be gained by electric driving both in small shops and large establishments, some points to be considered in the installation, etc. 2700 w. Aust Min Stand—May 16, 1906. No. 77469 B.

The Electrical Equipment of the Olds Gas Power Company, Lansing, Michigan. Description of a factory where they utilize the power developed in the testing department. 2200 w. Am Mach—Vol. 29. No. 24. No. 77276.

Electric Works.

The Western Electric Company, North Woolwich. An illustrated description of this English branch of this large manufacturing industry. 2500 w. Elec Engr, Lond—May 25, 1906. No. 77126 A.

Furnaces.

The Scientific Control of the Operation of Industrial Furnaces (Le Controle Scientifique de la Marche des Fours Industriel). H. le Chatelier. An address before the students of the University of Liége, discussing the extent to which the measurement of temperatures, analyses of gases, and scientific observations, enables close control to be secured. 10000 w. Revue de Métallurgie—June, 1906. No. 77671 H.

Gear Cutters.

The Gleason Bevel Gear Generator. Illustrates and describes an ingenious machine for the cutting of bevel gears, and explains the object sought by the combination of movements. 2500 w. Ir Age—June 21, 1906. No. 77404.

Grinding.

Earlier and Modern Wet-Grinding Machines and Practice. H. F. Noyes. A discussion of the grinding machine, considered as a cutting tool, showing the progress in design, scope, and performance. 3000 w. Engineering Magazine—July, 1906. No. 77682 B.

Grinding Machines for Large Ball Races. Illustrated description of a machine for grinding large ball races and rings used on pedestal gun mounts. 1200 w. Am Mach—Vol. 29. No. 22. No. 77058.

Modern Grinding. Joseph Horner. Comments on the advances made in precision grinding, and illustrates and describes types of grinding machines. 2800 w. Cassier's Mag—June, 1906. No. 77295 B.

Lathes.

A Huge Lathe. Illustration, with description, of a lathe weighing 240 tons recently constructed for steam turbine work for marine propulsion. 1200 w. Engr, Lond—June 1, 1906. No. 77272 A.

A Relieving Attachment for the Lathe. H. J. White. Engravings and description of a successful device for relieving taps and cutters. 700 w. Am Mach—Vol. 29. No. 23. No. 77216.

High-Speed Turret Lathe. Illustrated description of a new machine built especially for rapidly machining cast-iron work, such as gears, pulleys, cones and similar parts up to 15 inches diameter. 1200 w. Am Mach—Vol. 29. No. 25. No. 77407.

Molding.

Mechanical Moulding Operations in the Foundry (Le Moulage Mécanique des Pièces de Fonderie). Léon Guillet. A systematic discussion of the design and operation of moulding machines, with illustrations of machines of American, German, and French design. Serial. Part I. 3000 w. Génie Civil—May 12, 1906. No. 77613 D.

Two Ways of Molding a Heavy Gap Press Body, at the Perkins Machine Company's Iron Foundry, Warren, Mass. R. H. Palmer. Illustrated description of the methods. 2400 w. Am Mach—Vol. 29. No. 23. No. 77215.

Nuts.

Making Nuts and Rings Without Waste. An illustrated article explaining the principles of the three different methods used. 1700 w. Ir Age—June 28, 1906. No. 77500.

Perforating.

A Perforating Press. Explains why perforated screens are preferred to wire screens and gives illustrations and description of machine for handling plates up to 60 inches. 1200 w. Am Mach—Vol. 29. No. 26. No. 77526.

Portable Tools.

Portable Electric Tools and Their Industrial Application. Abstract of a paper by Andrew Stewart, read before the Glasgow Tech. Col. Sci. Soc. Discusses considerations involved in the design of such tools, and some of the types and their advantages. 3000 w. Mech Engr—May 26, 1906. No. 77131 A.

Rolling Mill.

A German Cold Rolling Mill. Illustrated description of a mill made in Düsseldorf, Germany. 1200 w. Ir Age—June 14, 1906. No. 77252.

Sand.

Notes on Moulding Sands (Notes sur les Sables à Mouler). M. Vinsonneau. An exhaustive study of the constitution and properties of foundry moulding sands, with diagrams and tables for practical use in mixing. 7500 w. Revue de Métallurgie—April, 1906. No. 77665 H.

Screws.

Automatic Safety Attachment for

Screw-Cutting. Illustrated description of an ingenious device which makes it mechanically imposible to close the claspnut except at the proper moment. 1000 w. Engng—June 8, 1906. No. 77388 A.

Shops.

The Construction of the Lidgerwood Plant at Waverly, N. J. Describes a new plant under construction for the manufacture of hoisting engines, cableways, etc., illustrating details. 2000 w. Eng Rec—June 9, 1906. No. 77237.

The Light Machine Shop. Edward H. McClintock. A discussion of its proportions and equipment. 3000 w. Mach, N Y—June, 1906. No. 77097 C.

The Passing of the Freeland Tool Works. An illustrated review of works founded in New York in 1845 and recently dismantled. 2200 w. Am Mach—Vol. 29. No. 23. No. 77214.

Steel Castings.

The Use of Steel Castings in Car and Truck Building. A. Stucki. Some of the desirable qualities of these castings are discussed. 800 w. R R Gaz—June 8, 1906. No. 77230.

MATERIALS OF CONSTRUCTION.

Alloys.

Recent Investigations upon Industrial Alloys (Recherches Récentes Faites sur les Alliages Industriel). Léon Guillet. A review of the modern theory of solid solutions, discussing the work of recent investigators, with especial reference to the practical applications of the newer alloys in manufacturing. 12000 w. Revue de Métallurgie—April, 1906. No. 77664 H.

Brasses.

A General Study of Special Brasses (Etude Générale des Laitons Speciaux). Léon Guillet. An exhaustive study of alloys of copper, zinc, and a third metal, the researches including brasses containing aluminum, manganese, iron, tin, lead, silicon, magnesium, antimony, or phosphorus. 20000 w. Revue de Métallurgie—May, 1906. No. 77667 H.

Effect of Arsenic on Brass. E. S. Sherry, in *The Brass World*. Showing that arsenic causes greater fluidity, and is not injurious unless more than 0.02 per cent. is present. 1000 w. Mech Engr—June 2, 1906. No. 77261 A.

Corrosion.

The Relative Corrosion of Wrought Iron and Steel. Henry M. Howe. A contribution to the discussion on the "Corrosion of Iron and Steel" at the meeting of the Am. Soc. for Test. Materials, June 22, 1906. 1400 w. Ir Age—June 28, 1906. No. 77499.

Overstrain.

Effect of Low Temperature on the Recovery of Steel from Overstrain. E. J. McCaustland. A report of tests made giving an outline of the scheme of experiments, with explanation of methods, conditions, and conclusions. 4500 w. Bul Am Inst of Min Engrs—May, 1906. No. 77176 C.

Shearing.

Shearing Strength of Structural Steels. Ch. Frémont, in *Revue de Métallurgie*. Reports experiments which lead to the conclusion that the shear diagram of an ordinary structural steel between two parallel cutting edges furnishes material for determining the elastic limit, the breaking strength, and ductility, with as much accuracy as the tensile test. 1800 w. Ir & Coal Trds Rev—June 8, 1906. No. 77392 A.

The Resistance of Structural Steel to Shearing (Résistance au Cisaillement des Aciers de Construction). Ch. Frémont. Discussing shearing as an action of tension and not of sliding, with diagram showing the relation of the shearing resistance to the elastic limit in tension. 4000 w. Revue de Métallurgie—May, 1906. No. 77668 H.

MEASUREMENT.

Bending.

A Simple Method for the Calculation of the Bending Strength of Curved Pieces. S. E. Slocum. Gives a method for calculating the strength of curved pieces having any form of cross section whatever. 1200 w. Eng News—May 31, No. 77040.

Cut-Meter.

The Warner Auto-Meter and Cut-Meter. Hugh Dolnar. Illustrates and describes the construction, operation, and calibration. 2500 w. Am Mach—Vol. 29. No. 25. No. 77409.

Centre of Gravity.

The Centre of Gravity of Spiraloid Systems (Centres de Gravité de Systèmes Spiraloides). Haton de la Goupillière. A study of the centre of gravity of masses arranged in a logarithmic spiral. 2000 w. Comptes Rendus—May 28, 1906. No. 77645 D.

The Determination of the Centre of Gravity of Discontinuous Systems (Centres de Gravité de Systèmes Discontinus). Haton de la Goupillière. A mathematical discussion, deriving general formulas for a number of bodies disposed in a circle. 2500 w. Comptes Rendus—May 14, 1906. No. 77642 D.

The Geometric Position of the Centre of Gravity (Lieux Géométriques de Centres de Gravité). Haton de la Goupillière. A mathematical examination of the position of the centre of gravity of a circular wire of increasing length. 2000 w. Comptes Rendus—May 21, 1906. No. 77643 D.

Crushing.

The Influence of Velocity upon the Law of the Deformation of Metals (Influence des Vitesses sur la Loi de Déformation des Metaux). P. Vieille & R. Lionville. Discussing the use of metal crushers for determining the pressures in guns, and showing the uncertainty of results made at such high velocities. 1000 w. Comptes Rendus—May 14, 1906. No. 77641 D

Elastic Limit.

Determination of the Elastic Limit of Metals (Mesure de la Limite Elastique des Métaux). R. Guillery. The elastic limit is determined by recording graphically the variations in the electrical resistance of the test piece while under tension. 3500 w. Revue de Métallurgie—June, 1906. No. 77670 H.

Micrometer.

A New Type of Micrometer. Walter C. Durfee. Describes what is called a rolling lens micrometer and its chief merit is said to be its ease of manipulation. 1000 w. Harvard Jour of Engng—June, 1906. No. 77333 D.

Pitometer.

The Pitometer and Its Uses. Edmund M. Blake. An illustrated description of this instrument and explanation of its uses in measuring the velocity of water in closed pipes. Discussion. 3000 w. Jour N Eng W Wks Assn—June, 1906. No. 77503 F.

Seismographs.

European Earthquake Recorders. Illustrates some of the instruments used and work of Prof. Milne, of the Shide Seismographic Observatory in the Isle of Wight, and in Italian observatories. 1800 w. Sci Am—June 16, 1906. No. 77286.

Speed Recorder.

Apparatus for Recording Rotative Speeds and Vibrations of Machines (Vorrichtung zum Aufzeichnen des Umlaufsgeschwindigkeit und des Ungleichförmigkeitsgrades von Maschinen). Friedrich Lux. Describing the application of a recording device to the Frahm speed and frequency indicator. 2000 w. Elektrotech Zeitschr—June 14, 1906. No. 77653 B.

Testing Machines.

Allowable Unit Loads on Knife Edges for Testing Machines and Heavy Weighing Scales. Jos W. Bramwell. Gives the writer's opinions which are based on extensive study of the weighing mechanism of testing machinery having knife edge supports for its levers. 700 w. Eng News—June 14, 1906. No. 77436.

Time Recorders.

The Calculagraph. An illustrated description of this machine and its mechanism, and of the method of using it in factory time keeping. 2000 w. Am Mach—Vol. 29. No. 22. No. 77056.

The "Dey" Time-Register. Illustrated description of a machine for registering the time of employés. 2000 w. Engng—June 15, 1906. No. 77486 A.

POWER AND TRANSMISSION.

Bearings.

The Lubrication of Bearings. A. M. Mattice. Practical matters in relation to the lubrication of bearings are discussed. 2000 w. Elec Jour—June, 1906. No. 77314.

Clutches.

Friction Clutches and Their Functions. An illustrated article, the present number explaining the construction of the ordinary cone clutch, the reversed cone clutch, cone clutch with split ring, and the expanding cylindrical ring clutch. 1300 w. Automobile—June 28, 1906. Serial. 1st part. No. 77536.

Compressed Air.

Air Compressors. Discusses the requirements, and gives illustrated descriptions of the important features in the designs of various makers. 15700 w. Engr, Lond (Sup)—June 15, 1906. No. 77484 A.

Compressed Air. Lucius I. Wightman. Brief review of the history, with discussions of its production, transmission and application. General discussion. 16500 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77299 D.

Conveyors.

The Belt Conveyor. Harold Sumner Farnham. From a lecture before the Mech. Engrs' class of 1906. Explains the fundamental principle of the belt conveyor, and illustrates and describes apparatus. 4500 w. Harvard Jour of Engng—June, 1906. No. 77332 D.

Elevators.

Electric Elevators. William Baxter, Jr. Describes elevator machines driven by electric motors, and illustrates several arrangements. 1800 w. Engr, U S A—June 1, 1906. No. 77081 C.

Some Notes on Braking Devices. Arthur W. Jones. On the reliability of the electro-magnetic brake, especially as applied to elevator gears. Ills. 1200 w. Elec Rev, Lond—June 15, 1906. No. 77475 A.

Friction.

Tests of "Compo" Cork Insert Friction Plates. John R. Nichols. Report of a test undertaken to determine the value of cork for increasing the frictional resistance of metallic surfaces in contact. 1000 w. Am Mach—Vol. 29. No. 23. No. 77217.

Gearing.

Diametrical and Circular Pitch. From the *English Mechanic and World of Science*. Explains these terms and the recent changes in their use and application, and gives the methods of calculating under each system. 2800 w. Sci Am Sup—June 9, 1906. No. 77255.

Planetary Gears. Andrew Strom. Illustrates a number of arrangements of planetary gears, explaining their advantages, and the formulas for obtaining the speed ratios. 1800 w. Am Mach—Vol. 29. No. 26. No. 77528.

Worm-Gear Design. A. M. Sosa. Presents a formula for computing the pitch and lead of a worm. 1400 w. Am Mach—Vol. 29. No. 22. No. 77060.

Power.

Modern Tendencies in the Utilization of Power. John J. Flather. A review of power developments in the United States which have made possible great economy in production. 4000 w. Engrs' Soc Univ of Minn—Year Bk, 1906. No. 77509 N.

Power Comparison.

Comparison between Steam and Electric Power in the Imperial Printing Office in Vienna (Vergleichende Angaben über Dampfbetrieb und Elektromotorischen Betrieb in der K. K. Hof und Staats druckerei in Wien). Leopold Nowotny. With diagrams of power curves and coal consumption, showing the advantages of electric driving. 1800 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—June 9, 1906. No. 77625 D.

Pneumatic Tubes.

An Improved Pneumatic Tube System. Illustrated description of a new system recently put in operation on some new lines installed for the Postal Telegraph Co., New York City. 2000 w. Eng Rec—June 2, 1906. No. 77074.

STEAM ENGINEERING.

Boiler Compounds.

The Intelligent Use of Boiler Compounds. R. L. Frank. Describes a method that has proved efficient and inexpensive, and costs about 25 cts. a horsepower. Ills. 3000 w. Engr, U S A—June 15, 1906. No. 77367 C.

Boilers.

Steam Boiler Inspections. Frank R. Fairweather. The various types of steam boilers in common use are considered, the causes of boiler explosions, and the importance of frequent inspections. Ills. 5000 w. Ins Engng—June, 1906. No. 77498 C.

The Hot-Air Boiler. Describes a pressure-generating device, known as a thermo-dynamic generator, explaining its action. 1200 w. Sci Am—June 16, 1906. No. 77284.

Condensers.

The Efficiency of Condensers and Its Effect on Power Station Costs. R. M. Neilson. A commentary and corollary on Prof. Weighton's paper before the Inst. of Naval Archts. Considers the ways the total cost per unit generated is affected by the condensers. 1400 w. Elec Rev, Lond—June 15, 1906. No. 77477 A.

Draft.

Draft. Discusses the removal of the gaseous products of combustion, and the supplying of the proper amount of oxygen.. Considers mechanical draft and when it is desirable. 3000 w. Power—July, 1906. No. 77525 C.

Economy Test.

Economy Test of a Skinner Engine. Reports a test made by Prof. R. C. Carpenter under actual running conditions, giving the results. 1500 w. Power—July, 1906. No. 77523 C.

Engine Economy.

Engine Economy as Affected by Unequal Cut-off. Thomas Hall. Investigations which tend to show that it is not necessary from the point of economy to have exactly equal adjustment of the cards for both ends of the cylinder, throughout the full range of cut-off. 1500 w. Power—July, 1906. No. 77517 C.

Engines.

Rebuilding a Large Rolling Mill Engine. An illustrated description of the compounding of an engine in the South Works of the Illinois Steel Co., the success of the work of installation and the remarkable record made in the time of installation. 1500 w. Engr, U S A—June 15, 1906. No. 77366 C.

Entropy.

The Practical Aspect of Entropy. J. H. Hart. An explanation of the meaning and importance of entropy by analogy with other physical and mechanical relations. 3000 w. Engineering Magazine—July, 1906. No. 77687 B.

Feed Water.

The Art of Water Softening. C. Herschel Koyl. General discussion of the subject, and brief consideration of the lime treatment, the soda treatment, and the mechanical treatment. 2000 w. R R Gaz—June 8, 1906. No. 77225.

Lubricator.

The Gravity Light-Feed Lubricator. Paul D. Phillips. Explains the working of a gravity lubricator, and the care needed. Ills. 1000 w. Power—July, 1906. No. 77520 C.

Pipes.

Some Facts About Steam Pipe Lines. Walter E. Dixon. Points of importance in the erection of steam pipe lines; the expansion and contraction, joints, leakage, etc. 1700 w. Power—July, 1906. No. 77524 C.

Some High-Pressure Steam Pipe Details. James Acton Miller. An illustrated discussion of wrought pipe, the bends, joints, welds, etc. 2500 w. Cassier's Mag—June, 1906. No. 77296 B.

Smoke.

Electricity and Gas V. Smoke. C. Alfred Smith. Principally a review of A. J. Martin's lecture before the Society of

Arts. 1800 w. Elec Rev, Lond—May 25, 1906. No. 77127 A.

Staybolts.

Concerning Staybolts. A discussion of the design and material of staybolts, quoting from various investigators, and giving tables of valuable data. 4500 w. Locomotive—April, 1906. No. 77426.

Superheating.

A New Form of Locomotive Superheater. Illustrated description of an application of the Notkine superheater to the locomotive boiler. 600 w. Ry & Engng Rev—June 16, 1906. No. 77354.

Remarkable Efficiencies in Small Engines Using Superheated Steam. R. E. Mathot. Gives results obtained in a test upon a Wolf engine of 40 h. p. working with superheated steam. Ills. 1500 w. Power—July, 1906. No. 77518 C.

Turbines.

Some Practical Experiences with Steam Turbines. C. E. Stanton. Read before the Iowa Elec. Assn. Considers step-bearing pumps, bafflers, strainers, valves, nozzles, lubrication, etc. 2800 w. Sci Am Sup—June 2, 1906. No. 77045.

The Present Status of the Steam Turbine. Reviews a report presented at the recent meeting of the National Electric Light Assn., giving results of investigations during the past year into the development of steam turbines and their maintenance. 5400 w. Eng Rec—June 16, 1906. No. 77338.

MISCELLANY.

Damascening.

Damascening and the Inlaying and Blending of Metals. Sherard Cowper-Coles. An introductory historical sketch of this art, describing the processes used in ancient times, and also of a new process and its results. Discussion. Ills. 5400 w. Jour Soc of Arts—June 1, 1906. No. 77182 A.

Inventing.

The Art of Inventing. Edwin J. Prindle. Remarks on this subject, with an illustrated description of how the cord knotter of the self-binding harvester was invented. 2200 w. Sci Am—June 23, 1906. No. 77419.

Liquid Air.

Liquid Air and Charcoal at Low Temperature. An account of an experimental discourse demonstrating some novel features of studies on liquid air and the application of charcoal at low temperatures. 2500 w. Engng—June 15, 1906. No. 77488 A.

Tinning.

Tinning. Translated from the German of Friedrich Hartmann's "Das Verzinnen, Verzinken, Vernickeln, etc. Discusses the process, the testing of tin, alloys used as substitutes, etc. 1800 w. Sci Am Sup—June 23, 1906. No. 77421.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Falls of Roof and Coal. Gives the recommendations issued by the Prussian Commission, with a view to preventing accidents. 900 w. Col Guard—May 25, 1906. No. 77136 A.

Africa.

The Geology of the Komati Poort Coal-Field. H. Kynaston. Abstract from the Trans. Geol. Surv. Repts. Description with report of full tests. 2000 w. Min Jour—June 16, 1906. No. 77472 A.

Bituminous.

Mine No. 2, St. Louis & O'Fallon Coal Co. Illustrated description of the equipment of a new bituminous coal mine of large capacity, near Belleville, Illinois. 2500 w. Mines & Min—June, 1906. No. 77183 C.

Briquettes.

Artificial Fuel. From the German of Dr. Theodor Koller. Mentions some attempts made to prolong the burning of coal, and especially describes in detail the manufacture of briquettes. 3300 w. Sci Am Sup—June 16, 1906. No. 77287.

British Columbia.

The Northern Interior Plateau Lying Between the Fraser and Skeena Rivers. W. F. Robertson. Extracts from a report giving information of this region, its minerals, principally coal, agricultural posibilities, etc. Ills. 9600 w. B C Min Rec—April, 1906. No. 77190 B.

Coal Testing.

Coal Testing Plant Report. Samuel Sanford. A review of the results accomplished by the plant at the St. Louis Exposition. 4300 w. Mines & Min—June, 1906. No. 77188 C.

Coke.

By-Product Coke and Huessener By-Product Coke Ovens. J. A. Roelofsen. Read before the British Inst. of Min. Engrs. Illustrates and describes these ovens stating the advantages claimed. 2500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77494 A.

Domestic Coke Manufacture. F. W. Parsons. Gives a sketch showing the general arrangement of a domestic coke plant capable of producing 50 to 100 tons per day, at comparatively small outlay.

600 w. Eng & Min Jour—June 16, 1906. No. 77311.

Electrically-Operated Coke-Drawing Machines. Frank C. Perkins. Illustrations showing details of construction and method of operating of a plant at Uniontown, Pa. 1500 w. Elec Engr, Lond—June 1, 1906. No. 77265 A.

Culm.

The Culm-Handling Plant at the Queen Louisa Coal Mines at Zabrze, Upper Silesia (Die Einführung des Sandspülversatzes auf dem Staatlichen Steinkohlenbergwerk Königin Luise bei Zabrze, O. S.). H. Arbenz. An illustrated account of methods of handling and disposing of the spoil in the coal mines of Silesia. 10000 w. 6 plates. Glückauf—May 19, 1906. No. 77627 B.

Indian Territory.

Oil, Coal, and Gas in the Muscogee Quadrangle, Indian Territory. Reliable information of this portion of the territory. 1500 w. Min Rept—June 7, 1906. No. 77209.

New Mexico.

Carboniferous Coal Measures in the Southwest. Charles R. Keyes. Information concerning coals of true Carboniferous age, recently discovered in New Mexico. 600 w. Eng & Min Jour—June 16, 1906. No. 77309.

Rescue.

The Organization and Training of Rescue Brigades. H. Meyer, in *Glückauf*. Considers the training of men in the use of the regenerative type of apparatus. 2200 w. Col Guard—May 25, 1906. No. 77135 A.

Tioga County.

A Brief History of Mining in Tioga County, Pennsylvania. Anton Hardt. From an address before the Historical Society at Wellsboro, Pa. Gives facts showing how much prosperity is due to the coal deposits. 2700 w. Mines & Min—June, 1906. No. 77184 C.

COPPER.

Arizona.

The Olive and Mineral Hill Camps of Pima County, Arizona. A descriptive account of the camps of this district, and the copper and lead-silver ores. 3300 w. Min Rept—May 31, 1906. No. 77089.

Fusing Point.

Notes on he Solidification of Copper (Remarques sur la Solidification du Cuivre). P. Dejean. A record of experimental researches, showing that pure copper solidifies at 1085 degrees C. 5000 w. Revue de Métallurgie—May, 1906. No. 77666 H.

Japan.

The Copper Mines of Japan. Illustrations and information concerning the mines, and their workings, production, etc. 1000 w. Eng & Min Jour—June 2, 1906. No. 77078.

New Jersey.

The Copper Deposits of New Jersey. N. S. Keith. Principally an illustrated description of the Schuyler mine at Arlington, and the Pahaquarry mine and property. 3000 w. Min Mag—June, 1906 No. 77328 C.

GOLD AND SILVER.

Africa.

Experimental Work in African Gold Mines. George E. Walsh. Describes new methods of grinding, and application of the cyanide process, filter pressing, etc. 2500 w. Mines & Min—June, 1906. No. 77186 C.

Rand Metallurgical Practice and Recent Innovations. G. A. and H. S. Denny. A brief outline of the work showing the direction and to what results the work leads. Also discussion. 9000 w. Jour S African Assn of Engrs—April, 1906. No. 77396 F.

ENG MAG—GAL 19

Routine Assaying on the Rand. A. Whitby. Remarks on the importance of the work in the mine assay office, with a sketch plan of a serviceable building for a 200-stamp mill, the equipment, the actual work of assaying, etc. Short discussion. 7000 w. Jour of Chem, Met, & Min Soc of S Africa—March, 1906. No. 77397 E.

Amalgamation.

The Amalgamation of Gold Ores. Thomas T. Read. Explains the nature of an amalgam, and discusses the amalgamation process and the influence of temperature. Ills. 10000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77177 D.

Assaying.

Gold Bullion Assaying. A. Douglas. Read at Melbourne, April 4, 1906. A detailed description of the work. 2500 w. Aust Min Stand—May 9, 1906. No. 77257 B.

Australia.

The Associated Gold Mines of W. A. Donald Clark. A summary of recent metallurgical progress in Kalgoorlie. 2000 w. Aust Min Stand—May 16, 1906. Serial. 1st. part. No. 77467 B.

California.

Gold Veins in Granite in California. W. H. Storms. Describes the characteristics of these gold-bearing veins. 3200 w. Min & Sci Pr—May 26, 1906. No. 77095.

Dredger.

The Robinson Gold-Dredger. Illustrates and describes a new gold-dredger of simple design, and its working. 1700 w. Engng—May 25, 1906. No. 77141 A.

Formosa.

The Gold Mines of Formosa. Acting Consul Crowe. An account of the mining since 1890, with information concerning the most important mines. 1200 w. Min Jour—June 2, 1906. No. 77267 A.

Hydraulic Mining.

Hydraulic Mining in a Cold Climate. J. P. Hutchins. A discussion of this method of mining and its problems, especially in relation to its use in the Klondike and other northern places. Ills. 4500 w. Min & Sci Pr—June 2, 1906. No. 77211.

Mexico.

Pachuca. H. E. West. Illustrates and describes this district which is a producer of precious metals. 3300 w. Min & Sci Pr—May 26, 1906. No. 77094.

The Taviche District, Mexico. Kirby Thomas. Describes the development of this mining camp, about 23 miles south of Oaxaca. Copper, gold and silver are produced. 2300 w. Min Wld—June 16, 1906. No. 77352.

Milling.

Milling Practice at the Dives-Pelican and Seven-Thirty Company's Concentrating Mill, Silver Plume, Colorado. Describes a mill designed to treat ore carrying a small percentage of high grade mineral and requiring fine grinding. 1500 w. Min Rept—June 7, 1906. No. 77208.

Placers.

Mergers in Placer Mining. J. P. Hutchins. Discusses benefits from merging, and the recent merger in dredge-mining operations. Ills. 2300 w. Eng & Min Jour—June 23, 1906. No. 77457.

Prospecting.

A Few Hints to Prospectors. Charles A. Bramble. Suggestions especially for prospecting work in the north of Canada and British America. 2000 w. Can Min Rev—June, 1906. No. 77363 B.

Sampling.

Note on the Sampling of Gold Alloys. Ernest A. Smith, in *Chemical News*. Information concerning the assaying of various gold alloys used by jewellers and goldsmiths, with tables of assays made. 1700 w. Min Rept—June 14, 1906. No. 77356.

Procedure to be Used in the Sampling and Settling of Ores Shipped to the U. S. Reduction & Refining Co. A copy of the sampling regulations recently issued, with editorial comment. 1600 w. Min Rept—May 31, 1906. No. 77088.

Silver Mill.

A Wet Silver Mill at a Montana Mine. Robert B. Brinsmade. Illustrates and describes the construction of the mill, the machinery used, and method of treating the ore. 5500 w. Mines & Min—June, 1906. No. 77187 C.

Slimes.

The Homestake Slime Plant. H. J. Baron. Describes a plant under construction for the economical cyanidation of gold-carrying slimes by filter pressing. 1400 w. Min Rept—June 21, 1906. No. 77462.

The Parrish Continuous Filter. Edward Parrish. Illustrations with description of a design for a continuous slime filter. 700 w. Eng & Min Jour—June 2, 1906. No. 77079.

Stamp Mills.

More Notes on Stamp Mill Practice. Courtenay de Kalb. Read before the Can. Min. Inst. Statements from experience, considering screens, foundations, stamp duty, mortar liners, shoes and dies, etc. 3000 w. Can Min Rev—June, 1906. No. 77365 B.

Timiskaming.

The Paragenesis of the Cobalt-Nickel Arsenides and Silver Deposits of Timiskaming. W. Campbell and C. W. Knight. Aims to determine the order in which the minerals which go to make up this ore, in Ontario, have been deposited, and to investigate the relation which the gangue bears to them. Ills. 2500 w. Eng & Min Jour—June 9, 1906. No. 77197.

IRON AND STEEL.

Bins.

Coke and Ore Bins. J. W. Pittman. Considers their construction, size, types, etc. General discussion and illustrations. 2800 w. Pro Engrs' Soc of W Penn—June, 1906. No. 77300 D.

Charging Machines.

Recent Improvements in Combined Ingot Strippers and Vertical Charging Machines. Drawings and description of alterations and improvements introduced. 1600 w. Ir & Coal Trds Rev—June 1, 1906. No. 77273 A.

Dry-Air Blast.

Notes on the Gayley Dry-Air Blast Process. C. A. Meissner. A further discussion of the paper of James Gayley, with special reference to his supplementary paper, and to the paper of J. E. Johnson, Jr. Also discussion. 14000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77174 D.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Handling.

The Handling and Conveying of Furnace Material (Zur Frage der Bewegung und Lagerung von Hüttenrohstoffen). M. Buhle. Describing various forms of dump cars, conveyors, unloaders, especially arranged for handling iron ore, etc. 3500 w. Stahl u Eisen—June 1, 1906. No. 77631 D.

Ingots.

Piping in Steel Ingots. N. Lilienberg. Considers the processes invented to obviate piping, and gives an illustrated description of the Illingworth casting machine. 2500 w. Bul Am Inst of Min Engrs—May, 1906. No. 77171.

Iron Mining.

Iron Mining on a Big Scale. From the *Mining Gazette*, Houghton. Remarks on the indications for a large demand, and the rapid work in progress on the Mesabi and Vermilion ranges. 1800 w. Min & Sci Pr—June, 1906. No. 77361.

Iron Ore.

Iron Ores Reserves. Charles Kenneth Leith. Showing that current estimates point to a short life for iron ore reserves, but that these estimates are low, and that low grade ore is not sufficiently considered. 2800 w. Can Min Rev—June, 1906. No. 77364 B.

Mining Soft Iron Ore Without Timber. Stuart Rhett Elliott. Describes a method of mining applicable to a variety of ore that drills easily, breaks and runs freely, yet is hard enough to stand for a considerable time over a large opening. 1200 w. Min & Sci Pr—June 9, 1906. No. 77358.

Manganese.

The Manganese Industry in India. Ralph Stokes. Illustrated article giving information of this industry, the deposits, working, etc. 1400 w. Min Wld—June 16, 1906. No. 77351.

Mine.

The Forest of Dean Iron Mine. An account of a historic property in Orange Co., N. Y., with illustrated description of the new equipment and work of reopening the mine. 2000 w. Ir Age—June 21, 1906. No. 77405.

Open Hearth.

The Chemical Action of the Acid Open-Hearth Furnace (Action Chimique du Four Martin Acide). M. Deslandes. Examining successively the behavior of the silicon, manganese, sulphur, phosphorus, and nickel, as observed in furnaces at the Schneider works. 3500 w. Revue de Métallurgie—June, 1906. No. 77669 H.

Rolling.

Improvements in Rolling Iron and Steel. James E. York. Explains the difficulties met in roll-designing, and gives an illustrated detailed description of the York universal mill, for rolling sections with wide flanges and their webs, or the usual sections, explaining its advantages. Also considers the making of steel ties. 4000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77172 C.

Smelting.

Official Preliminary Report of the Dominion Government, on the Experiments Made at Sault Ste. Marie, in the Smelting of Canadian Iron Ores by the Electro-thermic Process. Describes the furnace and electric holder, electrical machinery, experiments, etc., giving a summary of the results. 5000 w. Can Engr—June, 1906. No. 77191.

Steel Plant.

U. S. Steel Corporation's Great Plant at Gary, Ind. Diagram and description of a plant under construction at the extreme southern end of Lake Michigan. 3000 w. Ir Trd Rev—June 21, 1906. No. 77399.

MINING.

Costa Rica.

Mineral Deposits of Costa Rica. Francis C. Nicholas. An illustrated account of this island, reporting a well defined gold region, promising copper prospects, and an immense deposit of iron sand. 800 w. Min Wld—June 16, 1906. No. 77353.

Deep Mining.

Considerations on Deep Mining. George Farmer. Read before the British Inst. of Min. Engrs. Discusses high temperature, increased ventilation, working, pressure, lighting, explosives, mechanical appliances, winding, etc. 4500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77495 A.

Disaster.

The Catastrophe at Courriéres (La Catastrophe de Courriéres). E. Lemaire. A discussion of French legislation relating to the responsibility in cases of accidents in mines, with especial reference to the disaster at Courrières. 3500 w. Génie Civil—April 28, 1906. No. 77609 D.

The Disaster at the Courrières Mine (La Catastrophe des Mines de Courrières). E. Lemaire. A review of the entire situation at the Courrières Mine near Lens, France, describing the workings and the disaster of March 10, 1906. 3000 w. Génie Civil—April 21, 1906. No. 77607 D.

Electrical Machinery.

Experiments at Gelsenkirchen with Electrical Appliances for Fiery Mines. Bergassessor Beyling, in *Glückauf*. Gives a summary of the interesting conclusions from these experiments. 2000 w. Col Guard—May 25, 1906. No. 77134 A.

Freezing.

The Development of the Freezing Process Since its Introduction in 1883 (Die Entwricklung des Gefrierverfahrens seit seiner Ersten Anwendung im Jahre 1883). H. J. Joosten. A long tabulated account of various shafts sunk through quicksand by the aid of the Poetsch freezing process. 10000 w. Glückauf—June 2, 1906. No. 77630 B.

Haulage.

Notes on Top and Bottom Endless Rope Haulage on Curves at Bedlington Collieries. E. Graham. Read before the Nat Assn. of Colliery Mgrs. Illustrated description of the methods adopted. Discussion. 4000 w. Ir & Coal Trds Rev—June 8, 1906. No. 77394 A.

Joplin.

Joplin Re-visited. F. Lynwood Garrison. Notes on the changes in this lead and zinc district during the last six years. Ills. 2000 w. Min & Sci Pr—May 26, 1906. No. 77092.

Kaolin.

A Novel Method of Mining Kaolin. Albert R. Ledoux. Describes the method adopted by Mr. M. Wanner, at West Cornwall, Conn., for mining kaolin from deep deposits without shaft-sinking or removing of the overburden. 900 w. Bul Am Inst of Min Engrs—May, 1906. No. 77173.

Machine Mining.

Electrically - Driven Air - Compressors Combined with the Working of the Ingersoll-Sergeant Heading-Machines and Subsequent Working of the Busty Seam at Ouston Colliery. A. Thompson. Read before the British Inst. of Min. Engrs. Describes the work and compares the results and costs with hand labor. 3500 w. Ir & Coal Trds Rev—June 15, 1906. No. 77491 A.

Labor-Saving Machinery in Coal Mining. F. W. Parsons. Deals with the advances made in the mechanical handling of coal both under and above ground. 1700 w. Eng & Min Jour—June 16, 1906. No. 77312.

Practical Problems of Machine Mining. Sam Mavor. Read before the British Inst. of Min. Engrs. A brief review of a lengthy paper covering practically the whole field of machine mining. 1000 w. Ir & Coal Trds Rev—June 15, 1906. No. 77492 A.

Mine Workings.

A Reference Scheme for Mine-Workings. Wilbur E. Sanders. Explains the need and gives a reference scheme for numbering and naming points and parts of mine-workings. Plans. 3000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77170.

Nevada.

Manhattan. A. H. Halloran. An illustrated report of this mining district in Nevada, with a criticism of methods that have been tried to attract capital. 1800 w. Min & Sci Pr—June 9, 1906. No. 77359.

Ore Deposits.

The Practical Importance of Geology in the Study of Ore Deposits. John D. Irving. Aims to show that the geological relations of ore-deposits are the relations upon which the success of the metallurgical operations, the mining operations, and the accuracy of an estimate of the mineral wealth depend. 4000 w. Yale Sci M—June, 1906. No. 77371 C.

Pay-Streaks.

Following the Pay Streak. R. B. Nickerson. Describes the experience of a mine superintendent, and the difficulties encountered. 2300 w. Min & Sci Pr—June 9, 1906. No. 77360.

Quarries.

Wealth in Barre Granite. Alton D. Adams. An illustrated description of the large quarries at Barre, Vermont, and the methods of quarrying. 1700 w. Mines & Min—June, 1906. No. 77185 C.

Respirators.

Modern Improvements in Life-Saving Apparatus (Bericht über Versache mit Rettungsapparaten und über deren Vekbesserungen). H. Grahn. An account of tests with artificial respiration apparatus at the Shamrock shaft of the Hibernia mine in Westphalia. 6000 w. Glückauf—May 26, 1906. No. 77629 B.

Rock Pressures.

Rock Pressures as the Cause of the Fall in the Pribram Mines (Spannungen im Gesteine als Ursache von Bergschlägen in den Pribramer Gruben). Hugo Stefan. Reviewing several falls of rock in the Pribram mines in Bohemia, probably due to the pressure in the rock. 2000 w. Oesterr Zeitschr f Berg u Huttenwesen—May 19, 1906. No. 77626 D.

Shafts.

Misplacement of Shafts. E. J. Dunn. Concerning the Bendigo field, and the survey being made which will be a valuable guide to the correct position of future shafts. 1000 w. Aust Min Stand—May 9, 1906. No. 77256 B.

Sizing.

Screens for Sizing. Ernest A. Hersam. Gives tables of use in arranging a graded series of screens, following any mathematical law or the line of any curve, with remarks bearing on this subject. 7000 w. Bul Am Inst of Min Engrs—May, 1906. No. 77175 C.

Tube Mills.

Notes on Tube-Mills at El Oro, Mexico. Charles Butters. Notes on the operation of tube-mills at El Oro, with suggestions. 2000 w. Min & Sci Pr—May 26, 1906. No. 77093.

Tube-Mill Practice. W. R. Dowling. Discussing points of practical interest to those engaged in tube-mill work. Briefly describes the tube-mill equipment of the Robinson Deep G. M. Co. 5000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1906. No. 77398 E.

Veins.

The Evolution of a Mineral Vein. Arthur Lakes. An illustrated description of a mineral vein showing its geological features. 700 w. Min & Sci Pr—May 26, 1906. No. 77096.

Ventilation.

Some Examples of Modern Mine Ventilation. Describes the various methods now being employed in some of the northern counties of England and gives facts concerning the ventilating plants installed. Ills. 2500 w. Ir & Coal Trds Rev—June 8, 1906. No. 77395 A.

Winding.

Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work. W. C. Mountain. Read before the British Inst. of Min. Engrs. Gives tables showing the actual cost of winding by steam engines, and by electricity, and much information. 6800 w. Ir & Coal Trds Rev—June 15, 1906. No. 77490 A.

Electric Hoisting at the Noel-Sart-Culpart Collieries. Alfred Gradenwitz. Illustrated description of the plant installed in these mines in Belgium. 2000 w. Eng & Min Jour—June 9, 1906. No. 77199.

Steam Hoisting Engines (Ueber Dampf förder maschinen). Data and results of tests on hoisting engines, with indicator and load diagrams. 4000 w. Glückauf—May 19, 1906. No. 77628 B.

The Failure of Winding Ropes. E. King. An illustrated description of the "Kilindo" rope construction, and remarks on its wearing qualities. 1000 w. Min Jour—May 26, 1906. No. 77132 A.

MISCELLANY.

Diamonds.

The Diamond Mines of South Africa. Gardiner F. Williams. An interesting illustrated account of these mines, the miners, methods, etc. 3500 w. Nat Geog Mag—June, 1906. No. 77373 C.

Lead and Zinc.

The Wisconsin Lead and Zinc District. An illustrated description and historical review of this district. 2500 w. Eng & Min Jour—June 23, 1906. No. 77456.

Metals.

The Metals in Human Progress. Nelson P. Hulst. An interesting study of the use of metals as influencing the progress of civilization. 3000 w. Sci Am Sup—June 16, 1906. Serial. 1st part. No. 77289.

Mineral Earths.

Mineral Earths in South Dakota. Denis Henault. Concerning these deposits, especially of fuller's earth and volcanic ash. Min Rept—June 7, 1906. No. 77210.

Separation.

The Present Status of the Separation of Zinc Blende in Copper and Lead Ores. R. C. Canby. A review of the processes and devices used, and the advance made. 2200 w. Min Mag—June, 1906. No. 77329 C.

Sulphur.

Determination of Sulphur in Pyrites. C. R. Gysander, in *Chemical News*. Describes the hydroxylamine method, and compares the results obtained with the Lunge method. 100 w. Min Rept—June 14, 1906. No. 77357.

Tin.

A Volumetric Method for Tin. James Darroch and C. A. Meiklejohn. Describes a volumetric method, for estimating tin, which gives good results, and is applicable to all ores of the metal, and an assay may be completed in an hour. 800 w. Eng & Min Jour—June 23, 1906. No. 77455.

Brookstead Tin Field. H. Grant. A review of the development of the Brookstead lode, in North-eastern Tasmania, showing the richness of the field, and the importance of thorough prospecting. 2000 w. Aust Min Stand—June 6, 1906. No. 77875 B.

Substitutes for Tin. L. Parry. The recent shortage of the tin supply makes it wise to consider the question of substitutes, and the principal uses to which the metal is applied are discussed and how far other metals could take the place of tin. 2000 w. Min Jour—June 2, 1906. No. 77268 A.

Tin Deep Leads in Selangor. H. Herbert Noyes. Information concerning the deep leads of Malay Peninsula, and the peculiarities of Chinese miners. 1500 w. Min Jour—May 26, 1906. No. 77133 A.

Zinc.

Milling in Southwest Wisconsin. George S. Brooks. Concerning the methods of concentration in the zinc fields of the Upper Mississippi, describing the deposits and giving plan of the concentrator plant. 2200 w. Eng & Min Jour—June 16, 1906. No. 77310.

Notes on a Mill Test. Benjamin Hodge. Reports a test made on a small zinc mill in the Wisconsin district, showing high efficiency. 1200 w. Min Mag—June, 1906. No. 77330 C.

The Zinc Industry in the United States. H. S. Clark. The conditions in the different districts, the methods of mining, treatment, etc., and the inventions used in the different fields are considered. 3800 w. Min Mag—June, 1906. No. 77327 C.

Zinc and Lead Deposits in Wisconsin. U. S. Grant. Information concerning the geology, ore deposits, mining and concentrating, and prospecting. Ills. 3000 w. Min Mag—June, 1906. No. 77326 C.

Zinc Ore in Northern New York. D. H. Newland. Describes deposits in St. Lawrence County, giving map and information of interest. 1000 w. Eng & Min Jour—June 9, 1906. No. 77198.

Zinc-Ore Mining in Wisconsin. A review of the development since 1902, when the application of magnetic separation removed the iron sulphide from the zinc blende. Details of shaft-sinking, pumping and mining are given, with map of the Enterprise mine. 3000 w. Eng & Min Jour—June 30, 1906. No. 77743.

See Electrical Engineering. Electro-Chemistry.

CONDUCTING TRANSPORTATION.

Long Island.

Long Island Railroad. Considers the last report for the year ending Dec. 31, 1905, and the causes of the great increase in expenses. 1600 w. R R Gaz—June 8, 1906. No. 77218.

Motive Power.

The Motive Power Officer. G. M. Basford. An address delivered before the Mechanical Engineering Society of Purdue University. Explains the possibilities of the motive power problem, and some of the questions motive power men must decide. 4800 w. Ry Age—June 8, 1906. No. 77202.

Performance.

Locomotive Performance .Sheets. H. H. Vaughan. Describes the sheets in use on the Canadian Pacific, discussing the advantages of their arrangement. 2000 w. Am Engr & R R Jour—June, 1906. No. 77114 C.

MOTIVE POWER AND EQUIPMENT.

Brake Beams.

Brake Beams for 60,000, 80,000, and 100,000-lb. Freight Cars. Report of the Committee of the Master Car Builders' Assn. 3500 w. Eng News—June 14, 1906. No. 77437.

Car Ferries.

Car Ferry Lines of American Railroads. Gives statistics of lines operated by 35 companies, and illustrations, with description of methods and other information. 3300 w. R R Gaz—June 8, 1906. No. 77227.

Car Heating.

Mixed System of Heating Railway Trains by Steam and Water (Chauffage des Trains par la Vapeur et l'Eau Combinées). H. Guérin. A description of the Baudry system, used on the Paris-Lyons-Mediterranean line. Radiators containing water are heated by a circulation of steam. 2500 w. 1 plate. Génie Civil—May 12, 1906. No. 77614 D.

Car Lighting.

McElroy Automatic Car-Lighting System. This electric car-lighting system is illustrated and described in detail. 1500 w. R R Gaz—June 8, 1906. No. 77226.

The "Vickers-Hall" System of Electric Lighting for Railway Carriages. Illustrated detailed description of this system and its action, stating the advantages claimed. 2500 w. Elec Rev, Lond—June 1, 1906. No. 77266 A.

Cars.

Box Car with Hatches for Loading and Unloading Through the Roof: Tehuantepec National Railway, Mexico. Sectional plan, sectional side elevation with brief description and dimensions. 400 w. Eng News—June 21, 1906. No. 77412.

Freight-Car Construction and Its Commercial Aspect. L. H. Turner. A discussion of some of the weak points in car construction. 1500 w. Am Engr & R R Jour—June, 1906. No. 77116 C.

New Types of Goodwin Car. Illustrated description of a new design of flat bottom gondola dumping cars, having unusually large discharge openings. 1000 w. Ry & Engng Rev—June 9, 1906. No. 77213.

One Hundred Ton Capacity Flat. Illustrations, sections, and description of the car built for the Allis-Chalmers Co. 1000 w. Ry & Loc Engng—June, 1906. No. 77104 C.

Phosphate Cars for the Atlantic Coast Line. Illustrated description of a combination of a box car and a center dump hopper car, having a capacity of 80,000 lbs. 600 w. R R Gaz—June 8, 1906. No. 77222.

Standard All-Steel 60-Ft. Postal Car for the Harriman Lines. Drawings and description. 600 w. R R Gaz—June 22, 1906. No. 77447.

Standard 80,000-lb. Box Car for the Rock Island-Frisco System. Drawings and description of the standard design for a box car. 900 w. R R Gaz—June 8, 1906. No. 77219.

The 50-Ton Box Car as a Standard in Railroad Equipment. W. E. Symons. Discussing whether the results obtained from the use of the 50-ton car in actual service will justify its extended use in all localities as a standard car, in place of the 40 or 30-ton car. 3000 w. R R Gaz—June 8, 1906. No. 77220.

Draft Gear.

American Engineer Tests on Locomotive Draft Appliances. Committee report of the results of tests carried out, and the methods. 3000 w. Am Engr & R R Jour—June, 1906. No. 77119 C.

Friction Draft Gear on Cars and Locomotives. W. O. Thompson. Gives examples showing the importance of high cushion resistance, considers the measures of efficiency, and the different kinds of draft gear tests, etc. General discussion. Ills. 18000 w. Pro Cent Ry Club—May 11, 1906. No. 77293 C.

Electricity.

Report of Committee of American Railway Master Mechanics' Association on Electricity on Steam Railroads. 3000 w. Ry & Loc Engng—June, 1906. No. 77446 C.

Headlights.

Oil vs. Electric Headlights. S. A. Abbott. Read before the Int. Gen. Foremen's Assn. Sets forth the advantages claimed for the electric headlight. 1700 w. Ry & Loc Engng—June, 1906. No. 77106 C.

Locomotives.

Balanced Compound Locomotives. H. V. Wille. An illustrated article discussing features of these engines, which the writer considers the highest type produced. 1800 w. R R Gaz—June 15, 1906. No. 77281.

Baltimore & Ohio Railroad Motive Power. Descriptions and Illustrations of recent types of steam and electric freight, passenger and switching locomotives. 1500 w. R R Gaz—June 15, 1906. No. 77278.

Care and Maintenance of Freight and Passenger Engines at Terminal to Give Maximum Mileage and Efficient Service. E. T. James. A detailed consideration of this subject, followed by general discussion. 12700 w. Pro N Y R R Club—May 18, 1906. No. 77291.

Consolidation Locomotive for the New York Central Lines. An illustrated detailed description, with dimensions. 1200 w. R R Gaz—June 15, 1906. No. 77277.

De Glehn 4-4-2 on the Pennsylvania. Illustration, with brief description of a compound engine built in France. It is of the Atlantic type and fitted with Walschaert valve gear. 600 w. Ry & Loc Engng—June, 1906. No. 77105 C.

Fairlie Locomotive for the Bolivian Railways (2-ft. 6-in. Gauge). Illustrated description with principal dimensions. 900 w. Engng—June 8, 1906. No. 77387 A.

4-6-2 Passenger for the N. & W. An illustrated description of a single expansion 4-6-2 engine for the Norfolk & Western, for passenger service. 900 w. Ry & Loc Engng—June, 1906. No. 77103 C.

Lake Shore Heavy Passenger Locomotive. Illustrations, with dimensions of a 2-6-2 engine, said to be the heaviest passenger locomotive ever built. 400 w. Ry Age—June 1, 1906. No. 77085.

Latest Express Engines—Southeastern and Chatham Railway. Charles Rous-Marten. Illustrated description and dimensions of the latest design of Mr. Harry S. Wainwright, and an account of the work they are expected to perform is given in the present number. 2200 w. Engr, Lond—June 8, 1906. Serial. 1st part. No. 77389 A.

New York Central Electric Locomotives. Reginald Gordon. Presents a detailed description of these locomotives. Ills. 2000 w. R R Gaz—June 15, 1906. No. 77282.

Pacific Locomotive for the Southern Railway. Illustrated description of recently built (4-6-2) locomotives for passenger and fast freight service. 500 w. R R Gaz—June 29, 1906. No. 77537.

Pacific Type Passenger Locomotives. Remarks on this type of engine, illustrating the two kinds of trailing trucks used, and giving a table of the principal dimensions of several Pacific type passenger locomotives. 1500 w. Ry Mas Mech—June, 1906. No. 77181.

Prairie Type Passenger Locomotive with Walschaert Valve Gear. Illustrated description of a type of heavy passenger engines which are in service on the L. S. & M. S. Ry. 900 w. Am Engr & R R. Jour—June, 1906. No. 77113 C.

Recent Baldwin Locomotives. Illustrations of a 2-8-2 and a 2-6-2 type,with brief descriptions. 600 w. Ry Age—June 8, 1906. No. 77204.

Recent Development of American Passenger Locomotives. George L. Fowler. An interesting illustrated review of locomotive development. 3000 w. R R Gaz—June 15, 1906. No. 77280.

Simple Consolidation Locomotive with Walschaert Valve Gear. Illustrated description of the design known as Class H 6 B, for use on the Pennsylvania R. R. 800 w. Am Engr & R R Jour—June, 1906. No. 77120 C.

Simple Four-Cylinder Passenger Locomotive with Superheater. Illustrated description of a heavy, balanced, ten-wheel engine for the Belgian State Railways. 1500 w. Am Engr & R R Jour—June, 1906. No. 77117 C.

Some Recent Designs of Tank Locomotives. Photographs and particulars of three different types designed for specified service. 1200 w. Mech Engr—June 2, 1906. No. 77260 A.

The Development and Present Status of the Compound Locomotive in the United States. Editorial review of the history of the compound locomotive in the United States, with discussion of the work for which it is suited. 2000 w. Eng News—June 21, 1906. No. 77416.

Motor Cars.

A New Steam Rail Motor Car. Illustrated description of a new design with a statement of the advantages claimed. The car is built by James T. Halsey, Philadelphia 1200 w. R R Gaz—June 8, 1906. No. 77228.

A Petrol-Electric Rail Motor Car. Illustrates and describes an interesting type of petrol-electric motor car introduced by De Dion Bouton, Ltd. 1000 w. Tram & Ry Wld—June 7, 1906. No. 77401 B.

Benzine-Electric Railway Motor Car. (Benzinelektrische Selbstfahrer im Eisenbahnbetriebe). Jaromir Krizko. A combination railway motor car, with a dynamo driven by a combustion engine, delivering current to electric motors on the axles. Data and results of operative tests are given. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—June 8, 1906. No. 77617 D.

Gasolene Motor Cars. W. R. McKeen, Jr. Describes the motor cars of the Union Pacific Railroad, and reports their performance. 2000 w. R R Gaz—June 15, 1906. No. 77283.

The Esslingen Railway Motor Car (Der Eisenbahnmotorwagen der Maschinenfabrik Esslingen). A. Heller. Describing an independent steam motor-car, with vertical boiler, and superheater, and space for 16 seats, and a luggage compartment. Speeds of 56 kilometers per hour are attained. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 2, 1906. No. 77604 D.

Wheels.

Cast Iron Wheels. Discusses the strength and limit of load for cast iron wheels, the flange, and the rivalry of the steel wheel. 1000 w. R R Gaz—June 8, 1906. No. 77229.

Energy Expended on Car-Wheel Acceleration. Gives a calculation based upon particular specimens of wheel and only approximately accurate for general application. 1200 w. Sci Am Sup—June 2, 1906. No. 77046.

The Chilled Car Wheel from a Manufacturer's Standpoint. P. H. Griffin. Considers the troubles due to cheap wheels, and the bargaining for low prices, which has necessarily affected the quality. 2000 w. R R Gaz—June 8, 1906. No. 77223.

NEW PROJECTS.

Philippines.

New Railways in the Philippines. Percival E. Fansler. Describes present transportation facilities, and the possibilities for railway development, describing also the country through which the proposed roads are to pass. Ills. 4000 w. Cassier's Mag—June, 1906. No. 77297 B.

PERMANENT WAY AND BUILDINGS.

Coaling Station.

A Reinforced Concrete Locomotive Coaling Station of Unusual Construction on the Lehigh Valley Railroad. W. E. Phelps. A new concrete-steel station at South Easton, Pa., is illustrated and described. 1000 w. Eng News—June 14, 1906. No. 77441.

Pennsylvania R. R.

The Pennsylvania R. R. Extension to New York and Long Island: Structural Details of Long Island Power Station. Illustrates and describes in detail the novel and the more important structural features of the power house in Long Island City. 1700 w. Eng News—May 31, 1906. No. 77036.

Rails.

Rail Corrugation. G. Moyle. A technical paper issued by the Indian Government, reporting investigation into the cause of what is termed "roaring rails." Ills. 2000 w. Tram & Ry Wld—No. 77402 B.

Round Houses.

Improved Round House Facilities. J. C. Stuart. Remarks on the problems due to increase in size and weight of locomotives, with illustrated detailed description of the extensive improvements introduced on the Erie Railroad. 1600 w. R R Gaz—June 15, 1906. No. 77279.

Shops.

A Visit to the P., B. & W. Ry. Wilmington Shops. An illustrated article dealing with the most striking features noticed on a recent visit to these shops. 3500 w. Ry & Engng Rev—June 16, 1906. No. 77355.

Locomotive Shop Management. A. W. Wheatley. Offers a suggestion for a uniform classification of repairs, and also for other improvements in shop organization. 1600 w. Am Engr & R R Jour—June, 1906. No. 77118 C.

New Kingsland, N. J., Shops of the D., L. & W. Ry. Illustrated detailed description of recently modernized repair shops and their equipment. 2500 w. Ry & Engng Rev—June 9, 1906. No. 77212.

South Louisville Shops. This first of a series of articles illustrates and describes their general plan and operation. 1500 w. Am Engr & R R Jour—June, 1906. Serial. 1st part. No. 77115 C.

The New Shops of the Canada Car Company, Ltd., at Montreal. A recently completed plant, considered one of the best of the kind on the Continent, is illustrated and described. 3000 w. R R Gaz—June 8, 1906. No. 77224.

Signaling.

All-Electric Interlocking at Council Bluffs. Illustrates and describes a plant under construction on the Union Pacific. 2500 w. R R Gaz—June 8, 1906. No. 77221.

Block and Interlocking Signals in the Electrical Zone of the New York Central & Hudson River R. R. Illustrated detailed description of the extensive all-electric system. 3000 w. Eng News—June 14, 1906. No. 77434.

Block Signal System of the New York Central Electric Zone. The details of this interesting system are illustrated and described. It is known as the "Young System," and seems an important advance in the art of signaling. 3000 w. St Ry Jour—June 9, 1906. No. 77201 C.

The Brierley Fog-Signaling Apparatus for Railroads. Illustrates and describes an apparatus being tried on the Great Northern Railway of Great Britain. 1500 w. Sci Am—June 2, 1906. No. 77050.

Switchbacks.

Switchbacks on the Crown King Extension of the Santa Fé, Prescott & Phœnix Ry. Map, profile and plans, with description. 700 w. Eng News—June 21, 1906. No. 77413.

Terminal.

Victoria Station. Plans and description of reconstruction work of Victoria Station in London, now in progress. 3000 w. Engr, Lond—May 25, 1906. No. 77146 A.

Tracks.

Screw Spikes and Wooden Tie-Plates for Railway Track. Illustrates and describes the Thiollier system of rail fastenings which is in use in Europe, and is being tested by the Pennsylvania Lines. 1700 w. Eng News—June 21, 1906. No. 77415.

Track Elevation at Chicago on the Pittsburgh, Ft. Wayne & Chicago Ry. An illustrated description of the methods employed, which are of interest because of the height to which the tracks were raised, and the narrow space in which the work was done. 1200 w. Eng Rec—June 23, 1906. No. 77428.

TRAFFIC.

Pooling.

Car Clearing Houses and Car Pools—Benefits from Their Establishment. J. W. Midgley. An investigation of the subject of car pools, a car clearing house, an equipment company, and what has been termed a "legal tender" car, with the object of promoting economy and efficiency through the best possible employment of freight cars. 3000 w. Ry Age—June 1, 1906. No. 77084.

Car Pooling—Need of Remedy for Unfair Diversion of Foreign Cars. J. W. Midgley. A discussion of this problem and the difficulties in solving it. 3000 w. Ry Age—June 22, 1906. No. 77463.

Train Operation.

A Graphic Record of Train Operation. Gives a reduced chart made by a recording machine and a statement of the information shown on it. 1500 w. Ry Age—June 8, 1906. No. 77203.

MISCELLANY.

Anniversary.

Seventieth Anniversary of an English Railroad. W. B. Paley. Historical review of the South-Eastern Railway. Ills. 1200 w. R R Gaz—June 1, 1906. No. 77054.

Siam.

Railroads and Transportation in Siam. L. E. Bennett. An illustrated account of the work thus far accomplished, with the history, cost of construction, etc. 3800 w. R R Gaz—June 1, 1906. No. 77053.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Charlottenburg Subway (Die Untergrundbahn in Charlottenburg). P. Koch. With map showing the line from Berlin to the suburb of Charlottenburg, and illustrations of the work and the crossings. 1500 w. Elektrotech u Polytech Rundschau—May 17, 1906. No. 77660 D.

Cars.

Electric Street Cars for City Service. M. B. Starring, and H. B. Fleming. Illustrated detailed description of the Standard car for the Chicago City Railway Co., and its electrical equipment. Discussion. 10000 w. Jour W Soc of Engrs—June, 1906. No. 77504 D.

England.

Blackpool, St. Anne's, and Lytham Tramways. Illustrated description of the construction of these electric tramways, which are remarkable for the "straight runs," freedom from gradients, and small number of curves. 2000 w. Tram & Ry Wld—June 7, 1906. No. 77400 B.

Interurban.

Some Considerations as to Safety in the Operation of Electric Interurban Railways. An editorial review of matters affecting their safe operation, especially dealing with the larger and more important lines. 3300 w. Eng News—June 7, 1906. No. 77244.

The Southern Michigan Railway. Illustrates and describes a new line of electric interurban railways 24 miles in length, connecting St. Joseph and Niles, Mich., and gives an account of present and projected lines. 1700 w. Ry & Engng Rev—June 2, 1906. No. 77086.

Locomotives.

The Electric Locomotives for the Simplon Tunnel (Les Locomotives Electriques du Tunnel du Simplon). Describing and illustrating the new three-phase locomotives being built for the tunnel service by Brown, Boveri & Co. 3500 w. 1 plate. Bull Tech de la Suisse Romande—May 25, 1906. No. 77640 D.

The New Simplon Three-Phase Locomotives. Frank C. Perkins. Diagram and photographs with description of interesting details. 1000 w. Elec Engr. Lond—June 8, 1906. No. 77377 A.

Long Island.

The Power Transmission Line and Third-Rail System of the Long Island Railroad. W. N. Smith. Begins an illustrated detailed description of this high-tension electric line. 9500 w. St Ry Jour—June 9, 1906. Serial. 1st part. No. 77200 C.

The Power Transmission Line, and Third Rail System of the Long Island Railroad. W. N. Smith. Illustrated detailed description. 6800 w. Elec Rev, N Y—June 9, 1906. No. 77195.

The Rotary Converter Substations of the Long Island Railroad. W. N. Smith. Illustrates and describes the general scheme of power distribution to the several lines through rotary-converter substations. 11400 w. St Ry Jour—June 23, 1906. No. 77445 C.

Transmission and Distribution System, Long Island R. R. Illustrates and describes in detail the more important structural features of the transmission and distribution system. 4500 w. Eng News—June 14, 1906. No. 77433.

Mountain Road.

The Brunnen - Morschach Electric Mountain Railway (Die Elektrische Bergbahn Brunnen Morschach Schweiz). Wolfgang Adolf Müller. The road runs from Brunnen on the lake of Lucerne to Morschach, 258 metres above. It is a rack railroad, with three-phase electric traction; details of the line and locomotives are given. 3500 w. Zeitschr d Ver Deutscher Ing—May 19, 1906. No. 77601 D.

Operation.

A Study of Electric-Railway Operating Cost and Revenue. H. S. Knowlton. A discussion of the applications of the unit basis method of administration, with examples from representative roads. 2500 w. Engineering Magazine—July, 1906. No. 77686 B.

Paris.

The North-South Underground Railway in Paris (Le Chemin-de-fer Electrique Souterrain Nord-Sud de Paris). A. Dumas. A description of the new section of the Paris Metropolitain, connecting the Montparnasse quarter with Montmartre. 3500 w. 1 plate. Génie Civil—April 28, 1906. No. 77608 D.

The Paris Metropolitan Railway (Le Métropolitain de Paris). A. Dumas. A review of the projected extensions of the underground railway in Paris, together with a description of the extensive works now under construction, with maps and profiles. 10000 w. 5 plates. Gênie Civil—April 21, 1906. No. 77606 D.

Preliminaries.

Electric Railway Engineering Preliminaries. Sydney W. Ashe. Discusses the relation of trackage and traffic to population, and other matters to be considered in planning a new system of electric railways. 2500 w. Elec Rev, N Y—June 2, 1906. No. 77111.

Report.

Report of Electric Railway Test Commission. Review by Louis Bell, of the report of the Commission which served at the St. Louis Exposition. 2500 w. St Ry Jour—June 2, 1906. Serial. 1st part. No. 77068 C.

Signalling.

Automatic Signalling on the Underground Railways of London. Illustrated description of the system installed on the District Railway. The main feature is that currents extraneous to the signal system cannot affect the apparatus so as to cause a false indication of safety. 7500 w. Engng—May 25, 1906. Serial. 1st part. No. 77138 A.

Subway.

The Chicago Freight Subway. Editorial on this interesting engineering work, the useful function it is designed to serve, its capacity, operation, and effect on present conditions of freight service. 1200 w. R R Gaz—June 1, 1906. No. 77052.

Subway Temperature.

An Official Report on Heat Conditions in the New York Subway by Chief Engineer George S. Rice. A full statement of the conditions and possible remedies. 6500 w. Eng News—June 7, 1906. No. 77241.

Tests.

Experimental Work of the Electric Railway Test Commission. Henry H. Norris. A résumé of the results of the work of the Test Commission, and a discussion of the relation of the experiments to the general field of electric railway practice. 2200 w. Sib Jour of Engng—June, 1906. No. 77325 C.

Traffic.

Influences Determining Street Railway Traffic in German Cities. Wilhelm Mattersdorf. Considers the relations between the traffic and the population of a city; between the traffic and its determining operating factors; between operation and population; and the relation of car-kilometers run to passengers carried. 2800 w. St Ry Jour—June 2, 1906. No. 77057 C.

Wheels.

Rolled Steel Wheels for Interurban Service. H. S. Newton. Discusses facts in regard to these wheels as developed in the service of the Hartford & Springfield road; the amount and character of the wear, the carbon component, shop methods, for the re-shaping, and a comparison of the rolled-steel with the chilled-iron wheel. 4500 w. St Ry Jour—June 16, 1906. No. 77307 C.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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WAKE UP, AMERICA! MANUFACTURING METHODS WHICH IMPERIL OUR TRADE.

By Louis Bell.

It is almost exactly ten years since THE ENGINEERING MAGAZINE laid down the first clear definitions of that system of manufacturing which has come to be known as distinctively American. During the entire intervening period, these pages have been the repository of the leading literature of the subject—of the classics in the science of engineering as applied to mechanical production. We have numbered among our contributors most of the great specialists in the practice of "Production Engineering"—the modern profession based upon this highly modern literature—and the fundamental principles of systematized, specialized, standardized, and repetitive manufacture have been set forth more fully and lucidly here than anywhere else.

We should not be true to our course or our calling if we did not examine fully the bounds of these methods, and seek to show the limits of their power and range, as well as to exploit the regions in which they have undoubted sway. Indeed, the question as to these limits and the present relation of the American manufacturer to them is asked now by so many earnest voices that it should not go unanswered. We know no one who can speak to it more earnestly, more sympathetically, or more fearlessly than Dr. Bell. We commend his article to everyone interested in the manufacture or use of engineering appliances, as a leading contribution to the newer literature of production—a literature which shall be broader, stronger, more fully recognizant of all conditions and influences, even, than the old.—THE EDITORS.

SO wonderful has been the growth of American manufactures, and so sensational the resulting increase of wealth, that it seems almost ungrateful to suggest even the remote possibility of disaster; yet for some years past our more far-seeing economists have realized that there are dangers ahead. The immense resourcefulness of the American spirit has thus far won out, but each year foreign manufacturers are learning more from methods and applying what is best in them with remarkable shrewdness. So as time goes on we hear more and more frequently of the "German Peril" or the "Belgian Peril," or what not, which really means, without regard to nationality, a challenge to the industrial supremacy which we are striving to maintain.

Now, broadly, competition is a struggle of intelligence, of quick perception and adaptibility, of far-sighted appreciation of the world's wants. But unless the knowledge thus gained is diligently applied it will sooner or later fail of results. Just at this point lies the chief danger to American industry. The foreign peril lies not in foreign acuteness, but in the painstaking avoidance of our mistakes. Our real danger is not from without, but from within—the danger that comes from over-haste and lack of thoroughness.

These things are just as characteristic of American industry as is the marvellous alertness that has been its motive power. In the mechanical arts, for instance, American methods and workmen produce average results of remarkable excellence; but if one wants a bit of work done with the utmost thoroughness and precision, nineteen times out of twenty he will find that the workman who has finished it is a German or Swede or Englishman—if indeed he is able to get it done at all. As every thoughtful manufacturer fully realizes, there is a dearth of skilled labor, and native American skilled labor is the rarest kind. As a result the finest artisans in many lines of work are not to be found in this country, and the goods which they produce are imported.

If these conditions applied merely to a few articles of extraordinary character they would furnish no cause for anxiety, but as time goes on the list of high-grade importations lengthens ominously.

The fact is usually put lightly aside with animadversions concerning foreign pauper labor. American skilled labor is indeed relatively well paid, and the protective tariff is in theory supposed to take account of this fact. If, however, one examines the importations of fine mechanical goods it very quickly appears that they are brought in and sold as against native products, in spite of duties large enough not only to cover the difference in labor cost, but a large margin beyond it. In other words, the United States each year imports to the extent of many millions of dollars articles which could perfectly well be manufactured in the country and sold at a remunerative figure, did the American industrial system encourage the class of work which they represent.

This system has been sketched often enough in the pages of THE ENGINEERING MAGAZINE for its salient features to be familiar. Its primal intent is to produce, at the lowest possible cost, the largest possible quantity of marketable goods. To this end are subordinated the methods of production and the character of the product. The fundamental principle of the method is to reduce manufacture to operations by automatic machinery, using human labor only where it cannot be avoided, and constituting a manufacturing plant as a species of enormously complicated machine tool of which the workmen are merely belts, wheels, and oil-cans. The only real artisans are in the draughting room, the pattern shop, the tool shop, and at the inspection benches. Every part of the huge machine, animate and inanimate, is pushed up to its maximum output on the simple principle that its total working capacity during its life is a fixed quantity and the sooner it is worked out the larger will be the yearly product, and the more rapidly will the capital be turned over.

As with the process, so with the product. The cheapest product is a uniform one, and hence all works proceed, as far as possible, upon certain average types representing current average demands, or sometimes merely forms of minimum cost which have to be taken in default of anything better available. If a product can be run off by the mile and sawed up into convenient lengths afterwards, so much the better. As a rule, inspection is merely to determine present marketability—in other words, to avoid obvious "seconds."

Hence average quality is determined not by adherence to any ideals, but by the perfection of the working mechanism. It is mere justice to say that under favorable conditions this average may be extremely high. American watches, firearms, sewing machines, and so forth, have found their way to the uttermost parts of the earth, and for their price cannot be approached in quality—much less surpassed. Up to the point where machines need to be supplemented by a high degree of intelligent skill the American method works magnificently. At this point it becomes self-destructive, and all along the line it suffers more or less from too close adherence to the principle of averages upon which it is founded.

There is a constant tendency toward the production of types modified so as slightly to cheapen construction even at a considerable sacrifice of convenience; or, more serious still, manufacture is cheapened by designs which make repairs and renewals extremely troublesome, on the principle that it is better to scrap the article and buy a new one than to pay a little more for one that can be properly repaired. In similar fashion the high-pressure piece work results in turning out articles just capable of passing hurried inspection, and no more.

Doubtless these tendencies have their origin in the desire of the average public for bargains, nowhere keener than in America. In fact, our chief national foible may be described as the attempt to get an effect of regal magnificence for about $1.37½. Yet our industrial methods bear in the same direction by making high-grade work relatively very expensive. Anything, in fact, that departs from the established conditions made to suit the average demand, is punished. As an example take the medium-priced American hand camera. It is a marvel of adroit adaptation to the needs of the average purchaser and a really wonderful product for the money, but if one attempts to purchase apparatus of the highest grade it is rather cheaper to import than to buy in America, let alone the fact that most of the finest lenses are imported anyhow. The same condition holds for many other lines of manufacture. Indeed, certain classes of goods are practically unknown in American trade, and it sometimes happens that goods which would hardly pass inspection abroad are unloaded here as quite good enough for a people that is content with the cheap and tolerable.

Stern adherence to the principle of average demand thus leads foreigners to the opinion not altogether helpful to American trade, that American products are inherently second-rate—good second-rate, to be sure, but still much inferior to the best. This is actually untrue in the last analysis, but it has this much in its justification, that the American manufacturer does not find the largest profits in the limited demand for the highest classes of workmanship.

On the other hand, in very cheap goods—far below the average standard American plane—the foreigner sometimes beats us at our own game. The cheap Belgian gun, for instance, comes to this country, duty paid, at a price that staggers native production. The European is learning American methods, and with the advantage of cheap labor it is only a question of time before he can bring standard workmanship up to the American plane.

Our industrial organization, too, is such as to aggravate still further the evils which follow in the train of standardized output based on average demand. Of late years there has been a general movement toward large capitalization, based neither on investment nor conservative earning capacity, but on the estimated profits of a period of exceptional prosperity. As a result, work managers are often hard-pressed to keep up with the pace set by the financiers, and must strain every nerve to keep the product at its point of maximum profit by holding close to the cheapest lines of operation. Anything that yields less than the average profit is discouraged or abandoned, and new lines which may in their development cause a change of standard types are looked upon with aversion. The perennial question asked by the sales manager who sits next the financial throne is not : "Are we pushing ahead with the production to meet the inevitable trend of progress?" but "What line have you got to drop to get out those twelve million pieces of Type Q, No. 61, that our salesmen can unload before our fiscal year ends?" There is barely a foreman from Seattle to Tampa and San Diego to Eastport who will not recognize the sentiment, if not the phraseology .

Now right here lies the most imminent peril to American industrial supremacy. It has been won through long years of keen initiative of inventive genius, of resourceful improvement in methods. With a high cost of labor against him, the American manufacturer has kept ahead of the game by acting upon his foresight and keeping his methods in advance of all competition. A very few years of stagnant standardization and profit-taking will forfeit the hard-won lead and put the foreign competitor to the front. Already in certain lines it is perfectly evident that the improvements are being made abroad, and that they can be kept out of competition only by a high tariff, which at this particular time can hardly be considered a permanent reliance. It is a short-sighted policy that makes a period of great prosperity relatively unproductive in improvements. Worse than this, the greed for increased output is so great that production tends toward carelessness, and channels for competition are opened, never to be closed. For example, I know of several automobile works in which the forgings are largely imported from Germany in spite of the tariff. Experience has shown that the foreign product has a uniformity in properties very difficult to secure here, and that the parts are forged so closely to gauge that the saving in labor is enough practically to counterbalance the duty. Similar conditions appear in various other industries from time to time. The tendencies of the current policy appear most seriously in American export trade. Goods of types standardized for domestic trade do not always or often meet the requirements of, for instance, the South American markets, and the increasing demands of those countries are therefore filled through other channels held to less rigid bounds. At the present moment most American industries are behind their orders and do not worry about additional sales abroad; but some day in the not distant future these markets will be badly needed and can be won only at heavy cost, if at all. The trouble here, too, is not only with the products, but with the absolute indifference to commercial requirements. The whole tendency of our modern industrial machine is toward inflexibility and this extends to the methods of distribution as well. Foreign red-tape makes requirements which seem often unreasonable, but foreign business goes to the exporter who respects them. The American is too apt to treat them with lofty contempt, and suffers accordingly. Painstaking courtesy in meeting the possibly peculiar requirements of a foreign customer is a lesson that many American firms need sadly to learn. Every consignee won over by polite consideration is a self-appointed advertising agent whose services are extremely valuable.

This inflexibility and the system of production which it induces leads directly to the labor troubles which steadily increase in number and severity. As machinery has been perfected and the works has become a huge machine tool, so the workman has become less an individual. He rarely has a trade or even a legitimate calling, but rather the undivided *nth* of a trade and the vague fragment of a calling. Almost necessarily he ceases to be resourceful, and if thrown out of work becomes a recruit in the great army of the unemployed, enlisted there until an exactly similar job turns up.

The present situation is one that involves great and rapid changes in opportunities for work. There is no longer the flexibility that comes from the existence of trades, or anything like stability of production. It is no uncommon thing for branch works to shut down permanently to allow the centralization of a standardized manufacture, or for the output to be suddenly diminished to relieve over-production, in either case throwing out of employment a large force of men unfitted to take care of themselves. Hence they are the more apt to make unreasonable demands when they see production at a pace that forbids a lock-out. It is David Harum's motto: "Do unto others as they would do unto you, and do it fust." One cannot expect to find stability in the employed when there is no stability in the employment. As a matter of fact, it is very doubtful whether the total earnings of the average American workman over a period of fifteen or twenty years are materially greater than those of his foreign competitor, taking into account the difference in cost of living. Instability of employment, common in all lines and a recognized feature of many, goes far to compensate for the nominally greater wages of the American. The consequent feeling of insecurity is a demoralizing influence the seriousness of which it is hard to overestimate.

Of course there is no doubt about the temporary economy of the American system. To make an unlimited quality of a certain fixed line of articles, at a pace quickened or slackened as the sales rise and fall; to keep up the speed of the workmen by gradually dropping the price of piece work; to sell on long deliveries and short time—all these things keep capital moving rapidly and help pay the dividends.

Whether in long periods the same economy is shown and will be shown, is open to grave question. So long as a country is growing rapidly and can absorb goods and money and men rapidly, the present methods of manufacture can be expected to answer the purpose. In the day when there is greater stability in conditions and keener actual competition. natural selection will get to work and standardized mediocrity will not be among the fittest to survive. It is unsafe to reckon upon the indefinite continuance of combinations able to control supply and demand and to furnish what they will at whatever price they desire. Only the blind in spirit can fail to see the handwriting on the wall. Under normal industrial conditions enterprise and progressive anticipation of the world's needs can be counted upon to win over methods that depend absolutely upon an unlimited market, or complete control of it, to maintain profits.

Specialized manufacture will always have place in the world's work. The production of fixed types will inevitably be successful so long as these types are in demand, since a fixed product is cheaper than one often varied. Yet types of manufactured products rarely have a long life. Improvements are constantly made, and the old is superseded by the new. Standardization, however desirable from a pecuniary standpoint, in the last resort means the cessation of active improvement. In relatively fixed arts standard products may hold their own for many years, as in the case of certain textiles. In the mechanical arts, however, there is constant change by which the world has marched onwards, and even a brief halt may mean falling out of the ranks.

It is for this reason that the present note of warning is sounded. It is emphatically true that in very many lines of industry in our country active improvement has been checked in the interest of profit-taking. In the long run the effect of this is bound to be disastrous to American progress. There are signs even now of foreign competition based on an active campaign of improvements. In not a few of the engineering trades we are in this country copying European products instead of compelling them to copy ours, as of yore. Meanwhile the average quality of American labor is running down, owing to the practical abolition of integral trades, and it will be progressively harder to obtain the skill needful as the basis of improvement. Every great works feels the scarcity of skilled craftsmen, and the worst of the matter is that such have small incentive to existence in the face of the uncertainty of employment due to the general labor difficulties. When the rank and file of the workers strike, or the works are shut down on account of the latest merger, lumpers and skilled mechanics alike are idle.

There is a constant feeling of unrest among workmen under American conditions. They know that they are merely parts of a machine which stops and starts, accelerates and slows down, from causes absolutely beyond their control, and that each year they must take the chances of being displaced by cheaper men if such can be found available for filling the oil-cups.

Industrial conditions can probably never be restored to earlier forms. Labor-saving machinery, interchangeable parts, and systematized production, have their due place to fill in the world's economy. But they need not become, as they are becoming just at the present time, an excuse for stagnation. They should be the source of manifold lines of progress and be employed in working out new ideas instead of perpetuating old ones. And above all, they should not be allowed to check the development of the craftsman who is necessary to the perpetuation of industry. The greatest industrial problem to-day is to maintain the supply of active, intelligent, resourceful American labor in spite of the American system.

PATENTS AS A FACTOR IN A MANUFACTURING BUSINESS.

I. THEIR INFLUENCE IN MAKING MARKETS AND COMMANDING SUCCESS.

By Edwin J. Prindle, of the New York Bar.

The great fortunes won from patented inventions are before everyone's eyes. Rich opportunities of like kind may be lying near at hand, unrealized and undeveloped because of ignorance that they can be patented and given an immense market value, and further ignorance of the steps necessary to that end.

Mr. Prindle is a practical mechanical engineer, as well as a patent lawyer who has had entire charge of patenting, litigating, and successfully establishing some well-known recent inventions. He does not undertake, in the series of articles here begun, to make every manufacturer his own patent lawyer. He does, however, point out a whole range of hitherto generally unrecognized possibilities for profitable patents. He points out many important bearings they may have in the shop, in relations with employees, and in the sales office. He suggests many chances for pre-empting new markets or entering desirable ones. And in view of the international range of all large modern patent practice, his articles will have wide application.—THE EDITORS.

PATENTS have been one of the most important factors in the growth of the United States from a group of poverty-stricken, non-manufacturing dependencies to the greatest manufacturing country in the world. In fact the late Senator O. H. Platt of Connecticut, one of the profoundest minds in the United States Senate for the past thirty years, maintained that the American patent system has been the greatest factor in the material development of the nation.

Patents are the best and most effective means of controlling competition. They occasionally give absolute command of the market. enabling their owner to name the price without regard to cost of production, as for example where they cover all known forms of devices for accomplishing a given purpose. There are a number of great companies whose position commercially is, or has been, due almost wholly to the possession of controlling patents.

Among such corporations are the Bell Telephone Company, which, while it does not now depend largely upon its patents, was able to control the situation absolutely for many years, and to get itself so well located that it now has a practical monopoly in many cities, because of its being the first to occupy the field. The United Shoe Machinery Company is today in control of the manufacture and sale, or licensing, of the bulk of shoe-making machines, because of its patents; and this control, although several serious attempts to break it have been made by concerns heavily backed with money, the owners of the patents have been able to maintain. Ninety per cent of the welt shoes made in the United States are sewed upon machines which the United Shoe Machinery Company has been able to protect by means of its patents. The Westinghouse Air Brake Company built itself up on patents. Patents have played an important part in the development of the Westinghouse Electric Company and the General Electric Company. They have indeed become so well recognized a factor in commerce that these concerns, and many others, keep a large corps of inventors at work with a view constantly to improve their product so that they will be able to offer a product that is at least slightly better than that of their competitors, and which is so protected by patents that they do not have to compete with an article of equal merit. The time when the patents on their present products will expire is constantly kept in view, and they endeavor to have new ideas, similarly protected and ready to put on the market when the patents under which they are at present working shall have expired.

The reader will be able to recall many devices and processes which are now, or until recently have been, entirely within the control of a single concern. Take, for instance, the most successful forms of any of the following devices: the air brake, the cash-register, the steel car, the most popular stopper for beer bottles, the form of shoe-lasting machine most in use, the process of making the best armor plate, the commercial process of making calcium carbide, from which acetylene gas is generated, as well as the commercial form of the carbide itself; the incandescent gas-lamp, the phonograph and the graphophone. Even if a patent covers only the single feature of a device which makes it commercially the most desirable of its kind, still such a patent, so far as holding the market at the old price is concerned, often gives a complete monopoly. A patent covering a process or a machine for making a staple article, which process or machine effects such a saving in the cost of production as to enable its owner to undersell all others at a fair profit to himself, is as valuable, while that condition lasts, as a patent on the article itself, for the effect is to give him control of the market.

Patents are the only legal form of absolute monopoly. And they are absolute so far as they go. In a recent decision the court said:

> "Within his domain, the patentee is czar. The people must take the invention on the terms he dictates or let it alone for seventeen years. This is a necessity from the nature of the grant. Cries of restraint of trade and impairment of the freedom of sales are unavailing, because for the promotion of the useful arts the constitution and statutes authorize this very monoply."

The possession of suitable patents is, therefore, of great importance to the manufacturer. On the other hand, it is equally important to the manufacturer whose competitor has patents, to understand what limitations, if any, there are to his competitor's advantage, and how, if at all, a counter-advantage may be gained.

Having shown from this brief sketch the importance of the subject, the purpose and scope of the article may thus be stated:

I have found, in my practice of the law, that many—in fact most—owners of patents and of patentable inventions do not fully understand what their rights are under their patents; what, for instance, can be accomplished by means of them; how they can be bought and sold; how, while getting all the benefit possible in their own arts, those who own patents can sometimes make money out of their patents by permitting others to use the invention in other and non-competing arts; to whom an invention belongs that is worked out by an employee; how to protect one's self from being supplanted by improvements made by one's own employees; how to prevent a manufacturer's product from being used in a way not intended, or sold at a price below that desired by the patent owner.

While I do not aim to make the manufacturer his own lawyer, I do wish to open his eyes to what it is possible to do in connection with patents, not for the purpose of his doing it unguided by legal advice, but of suggesting to him to what ends to ask such advice. There are many manufacturers who could and would strengthen their position commercially through patents, if they but saw the neglected material at hand, or understood the fuller possibilities of material, of the availability of which they are already partially aware.

The Subjects of Patents.

And first of the subjects of patents: There are four classes of inventions for which patents are granted, viz, arts, machines, manufactures and compositions of matter. It is not intended to give exact definitions of these classes of inventions, but merely to illustrate their scope, so that a manufacturer may be led to inquire whether or not an invention that falls under his control is patentable. My observation has been that the mistake is often made of failing to patent inventions which might have been patented, but which the layman decided for himself were not patentable.

With this explanation, I may say, that an art may be any process, or series of steps or operations, for accomplishing a physical or chemical result. As examples may be mentioned: the art of telephoning by causing undulations of the electric current corresponding to the sound waves of the spoken voice; or of casting car wheels, which consists in causing a jet of molten metal to enter the mold in a tangential direction to give the metal a whirling motion, so that the heavy sound metal will flow to the rim of the wheel and the cinders and bubbles will thus not occur on the rim. The patentability of a process does not depend on the apparatus with which it is carried out. The apparatus may be old, and the process may consist in a new way of using an old apparatus. The fact that no new mechanism may be required in practicing the process is apt to mislead the manufacturer into thinking there is no patentable invention present. In the case of the process of casting car wheels, the same old mold and ladle could be used, and the invention consisted in holding the ladle so that the metal would strike the mold tangentially and thus get whirling motion in the mold, instead of simply pouring the metal straight in, which would mix the cinders, bubbles, and sound metal together.

A manufacture is anything made by the hand of man that is not an art, machine, manufacture, or composition of matter. A safety pin, a tooth brush, and a whistle are all articles of manufacture.

A machine is any assemblage of mechanical elements having a law of action of its own. A steam engine and a jack knife are both machines. The distinction between an article of manufacture and a machine is not important.

A composition of matter is any mixture or combination of chemical elements, whether solid, liquid, or gaseous; such as calcium carbide, from which acetylene is made, acetylene itself, a soap, or a tool steel.

A new combination of old elements may be patentable, if it produces a new or improved result, or an old result in a new way. A combination of elements may be patentable as a whole, and some of its sub-combinations may be patentable. A new form of an element of a combination that is old as a whole may be patentable. Improvements and attachments on old machines may be patentable. A new use of an old device or machine or process may be patentable, if the new use is so different from the old use as not to be obvious to an ordinary skilled workman in the art. In such a case, and with all subjects of patents, the courts require that the alleged invention or discovery be one that is not obvious to the ordinary skilled workman in the particular art, and they hold it must be so far from obvious as to require the exercise of the inventive faculty. There is no rule by which all cases can be judged, but each case is decided on its own merits. If an invention has long been sought for without success, the courts will usually sustain the patent, no matter how obvious the invention appears after it has been disclosed.

THE NATURE OF A PATENT.

A patent is a public grant, in the nature of a contract between the government and the inventor. The inventor on his part is required to disclose fully a new and useful invention or discovery which he has made himself. If the invention is not new to the public at the time the inventor makes his invention, then the inventor has given nothing to the public which it did not already have; if the inventor has kept back some essential part of the invention, so that he has not fully put the public into possession of a knowledge of the invention; if the invention is not operative, or is injurious to the public health or morals, so that it is not useful; if the patentee did not invent or discover the invention, but learned of it from others—then in all these cases he has not given the public a proper consideration for the patent, and the patent is invalid.

The law also requires that the invention shall not have been described in a printed publication or have been in public use or on sale for more than two years before the inventor filed his application.

A patent consists of a deed, signed and sealed by the Commissioner of Patents, granting to the inventor the exclusive right for seventeen years to make, use, and sell the invention, and referring to the attached specifications and drawings (if there be drawings) for a disclosure and definition of the invention.

The grant of a patent purports, as just stated, to give the inventor the right to make, use, and sell the invention; but in legal effect it really gives him only the exclusive right to prevent others from making, using, and selling the invention. If his invention happens to embody the principle of some invention that is covered by a previous patent, the owner of the previous patent can prevent the making, using, and selling of any embodiment of the later invention using the earlier principle, and the later patentee must either make terms with the earlier patentee or wait until the earlier patent is dead. But the later patentee can prevent the earlier patentee or anyone else from using the later invention during the life of the later patent.

THE CLAIM OF A PATENT.

As some, and even the greater part, of the machine or other device shown in a patent may be old and not patentable, and the part invented by the patentee may be, and usually is, less than the whole, the patentee is required to state in terms just what his invention consists in, and such a statement or statements are called "claims." They are the measure of the grant, the latter (but for the name of the patentee and the title of the invention) being the same in all patents. There is no piece of English composition that is more generally misunderstood than the claim of a patent. But the general nature of a claim (which is all I propose in this paper to treat) is not beyond the comprehension of the layman.

A claim is not a statement of advantages of the invention, but it is a more or less precise technical description of the invention. A strange thing about a claim is, that the more it says, the less it means. As a specific example: suppose John Doe invented a turret lathe, consisting of a bed having a head-stock on one end, a spindle journalled in the head-stock and a chuck on the spindle, a slide mounted on ways on the bed, a turret on the slide, a series of tools in the turret, a rack on the slide engaged by a pinion on the bed, and a hand wheel for turning the pinion, so that the slide and turret could be advanced to cause each tool to engage the work. His claim might read as follows:

"I claim a machine tool consisting of the combination of a bed having ways, a head-stock on said bed, a spindle journalled in said head-stock, a chuck on said spindle, a slide mounted on said ways, a turret revolubly mounted on said slide, a series of tools mounted in said turret, a rack on said slide, a pinion journalled on said bed and engaging said rack, and a hand-wheel for turning said pinion, whereby a piece of work may be secured in and revolved by said chuck, whereby said turret and tools may be advanced against and retracted from the work, and whereby said turret may be turned to bring its various tools into cutting position."

Now suppose Doe's turret lathe was the first machine ever invented in which the work was revolved, and a tool mechanically held on a slide was moved against the work. The principle of his invention, stated that broadly, is found in a lathe without a turret; in a boring mill; in a pipe-threading or cutting machine, and other machines; and under the supposition that his was the first machine to move a tool mechanically against a mechanically-revolved piece of work, all of these other enumerated machines are supposed to have been invented after his machine. But they are not described by his claim; because, for instance, they do not have the turret with its series of tools. So the courts would hold that they were not his invention as stated in his claim. And yet they all manifestly use his principle of mechanically revolving the work, and moving a mechanically-held tool against the work.

The courts will not allow a patentee who states in his claim that his invention consists of the combination of five elements, to claim infringement by a machine that has only four of those elements, and has no equivalent of the fifth element. While they will imply or read an element into a claim from the specification, if such element is necessary to make the combination stated in the claim complete and operative, and thus save the claim from being void, they will never read an element out of a claim. So, although the claim above is a fairly good word-picture of the machine which embodies Doe's invention, it is evident it does not protect the principle or essence of the invention.

Suppose, now, the claim read as follows:

"I claim a machine consisting of the combination of a frame, means mounted on said frame for revolving a piece of work, guides on said frame and extending toward the position of the work, a part mounted in said guides, a tool on said part, and means for moving said part to carry the tool against the work."

This claim is just as true a description of the Doe lathe, so far as it goes, as was the first claim, and yet it is an equally true description of a lathe without a turret, of a boring mill, and of a pipe-cutting or a pipe-threading machine. So that Doe could justly claim those machines were within his monopoly and that they could not be made, used, or sold without his consent while his patent was in force.

The popular idea is that the more complete a description a claim is of the particular embodiment of the invention shown in the patent, the better claim it is; but the example of the Doe claims shows the fallacy of this idea. It is as though the claim were a bill of sale giving title to cattle on a large Texas ranch. If it gave title to "all the short-horn Durham steers having one white fore foot and three red feet," the purchaser would get very few cattle. If, however, the bill of sale gave title to "all the live stock" on the ranch, the purchaser would not only get all the short-horn steers with only one white foot, but he would get all the steers of every description, and all the heifers, bulls, horses, and pigs there might be there.

The mistake arises from supposing the best form of claim to be a detail description of the particular embodiment of the invention shown in the patent, when it should be a description of every class of machines which embodies the principle of the invention, whether or not the details not essential to that principle are copied. In other words, the claim is not a list of elements, whose virtue is greater the larger the number of elements enumerated; but it is a description of a class of combinations of elements, and the fewer elements stated, the larger the class of machines is likely to be in which that combination of elements is found.

Perhaps another simile may not be amiss. A claim is like giving one the title to everything that can be found that will fit into a box. Now if no particular kind of box were specified, the grantee would have a very valuable monopoly. Everything that would go into a square, or a round box, or an oval box, or into a star-shape box would be his. But if the box were stated to be a round box having a pin set up in the centre of its bottom and extending up to a level with the top of the box, it is evident nothing could be put into the box but round things having a hole through the middle, and the grantee would have a very much less desirable monopoly.

The popular misunderstanding is doubtless due to the fact that, as before stated, the actual language of a patent is a grant of the exclusive right to make, use, and sell the invention, while its legal effect is only a grant of the exclusive right to *prevent others* from making, using, and selling the invention. The language of the patent is to this effect: "John Doe is hereby granted the exclusive right to make, use and sell a machine consisting of the combination of elements A, B, C, etc.," and the longer the list of elements, the larger appears the monopoly granted. The legal effect, however, is: "John Doe is hereby granted the exclusive right to prevent others from making, using or selling any machine consisting of the combination of elements A, B, C, D, etc.," and the longer the list of elements, the fewer machines there will be that will answer the description and come within his monopoly.

The Supreme Court of the United States has said that the claim of a patent is one of the most difficult pieces of English composition to write. It is often thought that the particular wording of a patent is not important, the skill required being in enforcing the patent in court; but it must now be clear that there is great opportunity for skill and foresight in drawing the patent. A well drawn patent may make plain sailing in court, while a poorly drawn patent often has a hole in it through which serious competition can escape.

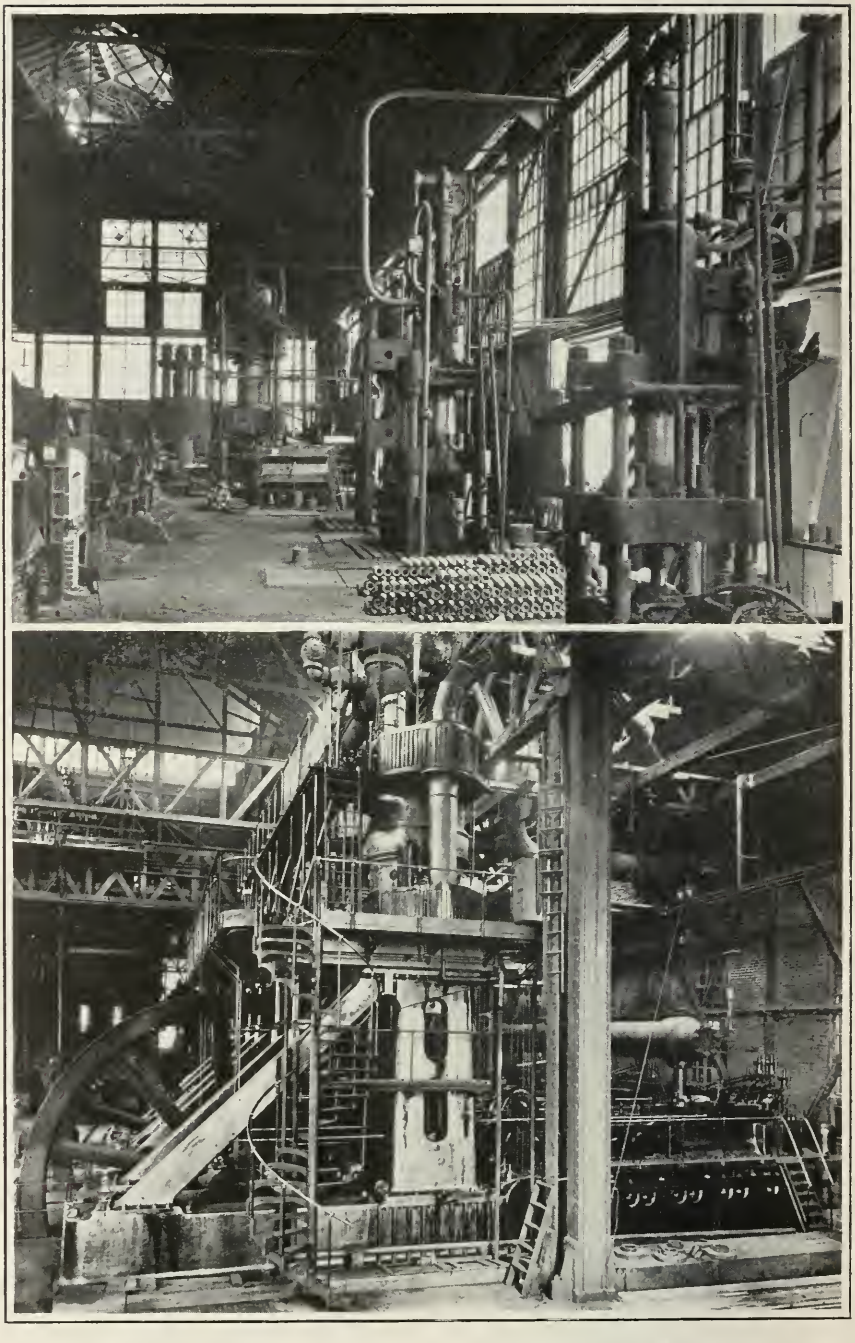
THE MECHANICAL USES OF WATER UNDER PRESSURE.

By Wm. M. Barr.

In two preceding articles, appearing in this Magazine in January and June, 1905, Mr. Barr discussed the "Development of Power Pumping Machinery" and the "Hydraulic Applications of Motive Power"; that is, he dealt with the topic from the point of generation and transmission. Now he takes up possibly the most interesting phase of all—the direct utilization of water pressure in moving machinery, and the principles governing the design of the machines employed. —The Editors.

EACH year brings new requirements in manufacturing industries which call for the use of water in pressure systems. This pressure may vary anywhere from 300 pounds to 1,500 pounds in live loads, and as high as 6,000 pounds per square inch for final pressures. The introduction of hydraulic presses in steel making has led to economies which could not now be dispensed with; the practice of subjecting a mould filled with molten steel to hydraulic pressure is beneficial in expelling the entrained air, and thus preventing the formation of cavities or blow holes in the steel, as well as preventing surface cracks due to tension created in cooling. The amount of pressure to be exerted upon an ingot will depend upon its size, but in any case is rarely less than 1,000 tons. At the Bethlehem Steel Company's Works the capacity of the hydraulic press for the fluid compression of ingots is upwards of 7,000 tons. This method of treatment yields a larger tonnage of commercial product, and of better average quality than had been heretofore obtained.

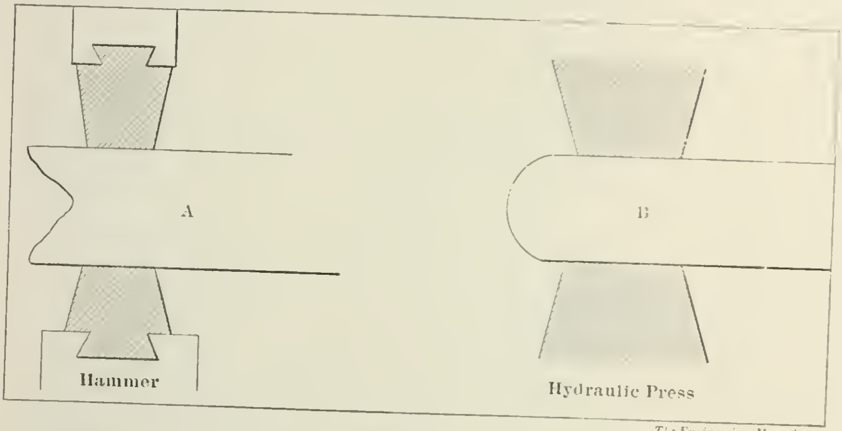
The complete displacement of wrought iron by mild steel in engineering work is practically an accomplished fact. Large masses of wrought iron, such as engine shafts, were not only difficult to forge, but when delivered had a fibrous structure due to contained slag which could not escape during the process of welding. The presence of slag so far reduced the elastic limit of such forgings that 20,000 pounds per square inch was regarded as the practical limit. The adaptation of hydraulic machinery to the work of squeezing steel ingots into such shapes as are required in engineering practice, and especially into large shafts or high-powered ordnance, has had the effect of producing shapes which are not only homogeneous throughout, possessing a much higher elastic limit, though made at less cost.



PART OF THE HYDRAULIC EQUIPMENT OF THE BETHLEHEM STEEL CO.

The upper view is taken in the press shop and shows the hydraulic presses and accumulator The lower one shows the 15,000-horse-power engine furnishing water to the 14,000-ton armor-plate forging press illustrated on page 820. Bethlehem Steel Co., Bethlehem, Pa.

In working thick masses of metal, the flow of the metal is observable at the ends of the ingots, hammer-forging drawing the outside of the ingot beyond the center as in Figure A, whereas the effect of a hydraulic press is shown in Figure B; the difference being that the hydraulic pressure is felt to the center, a flow of metal occurring along the neutral axis of the ingot. Hydraulic forging presses of 5,000 to 15,000-tons capacity are now employed in American steel works, a 14,000-ton press at the Bethlehem Steel Company being served by a 15,000-horse-power pumping engine. It needs but slight knowledge of the subject to understand that for the heavier class of forgings, such as is required for ordnance and marine work, the hydraulic is the only practicable method.

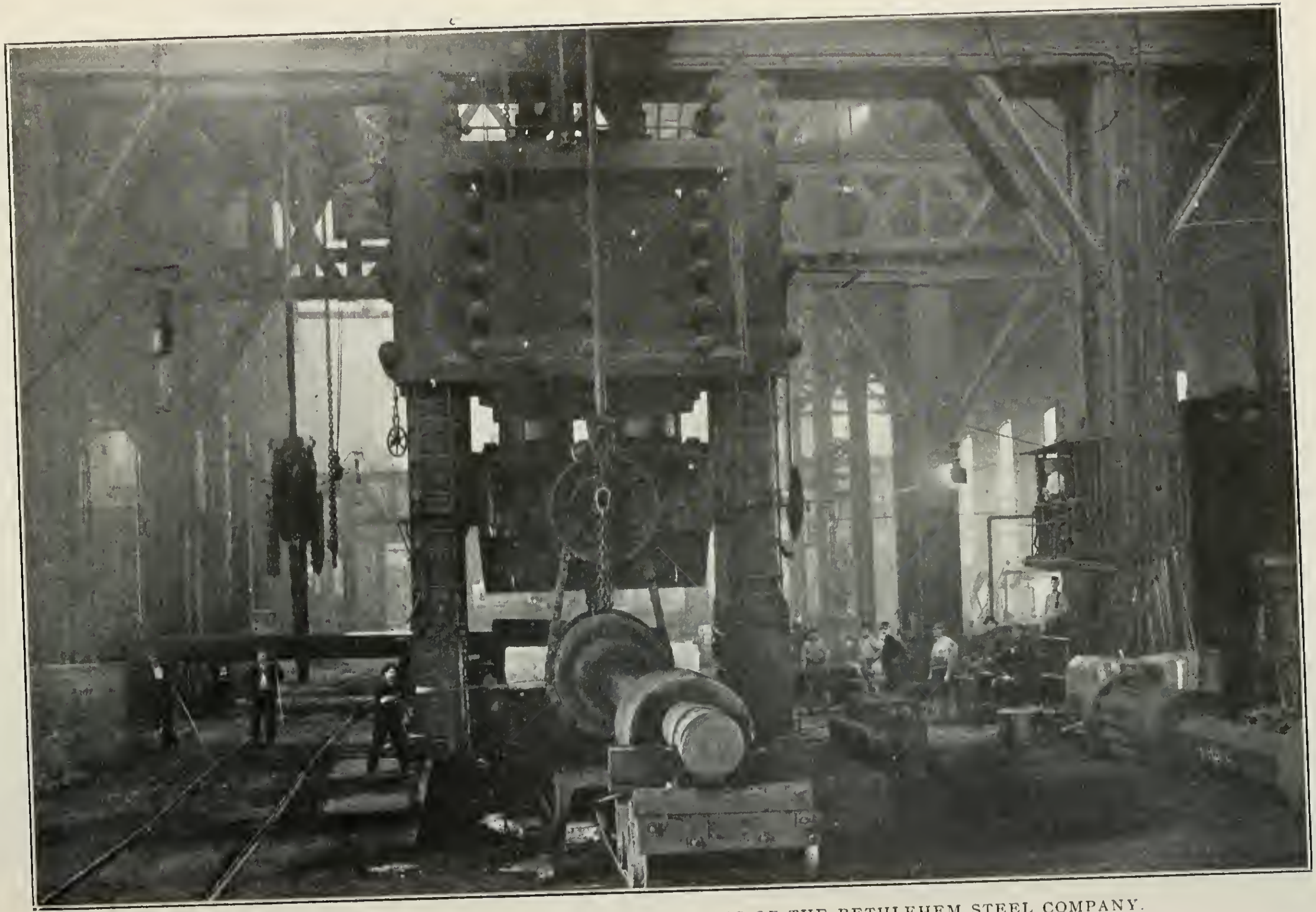


The Engineering Magazine

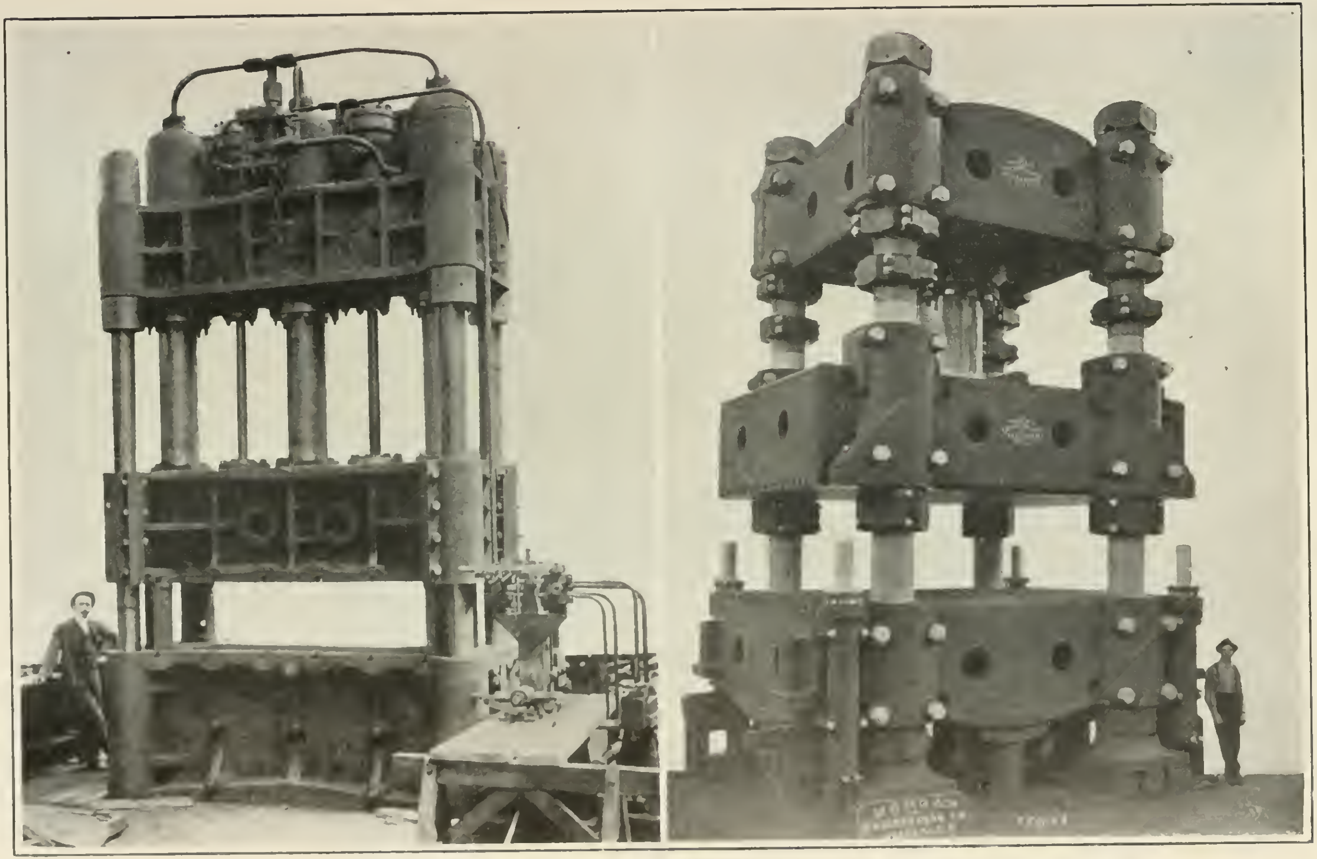
THE COMPARATIVE EFFECTS OF HAMMER FORGING AND HYDRAULIC PRESSURE.

The effect of such a hammer blow as would be employed in forging a shaft, say 16 to 20 inches in diameter, is confined largely to the surface; that is to say, it would not exceed in any case, one-fourth its diameter, and in all probability much less, the center of the forging remaining, meanwhile, almost wholly undisturbed. In the case of hydraulic squeezing, the element of time is an important one, and the effect of the squeeze is such as to compress the material of the shaft to its center.

Hydraulic plants consist essentially of a pump, an accumulator, and the hydraulic cylinder and ram to be operated upon by pressure. Nearly all hydraulic-pressure pumps are steam-driven. Nearly all are direct-acting pumps; therefore, the highest economies are not to be expected at this end of the installation. Usually pressure is the only thing considered, and, as the action of the accumulator is irregular, and the operation of the pump is automatically controlled by



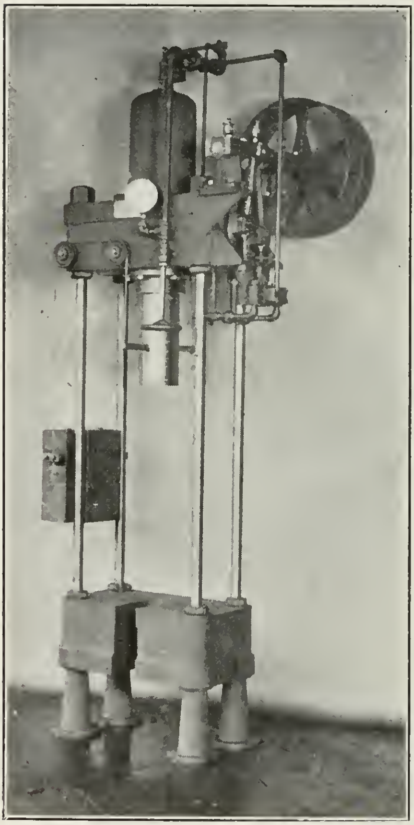
THE 14,000-TON HYDRAULIC ARMOR-FORGING PRESS OF THE BETHLEHEM STEEL COMPANY.



EXAMPLES OF AMERICAN AND OF BRITISH DESIGNS OF 1,000-TON HYDRAULIC PRESSES.

The press on the left, built by the Vauxhall & West Hydraulic Engineering Co., Luton, Bedfordshire, is specially designed for the manufacture of gun carriage parts and gun shields; quick-acting water saving valves effect an economy of water and permit a working speed of 30 short strokes a minute. The press on the right, built by the Morgan Engineering Co., Alliance, Ohio, measures 9 ft. by 9 ft., center to center of column bolts, and is equipped with main plunger, lower or clamping plunger, and four push backs.

the movement of the accumulator, the pumps may vary from the highest speed attainable to zero—conditions which are not favorable to the employment of crank and flywheel pumps, unless there are several machines operating from the same delivery pipe line.



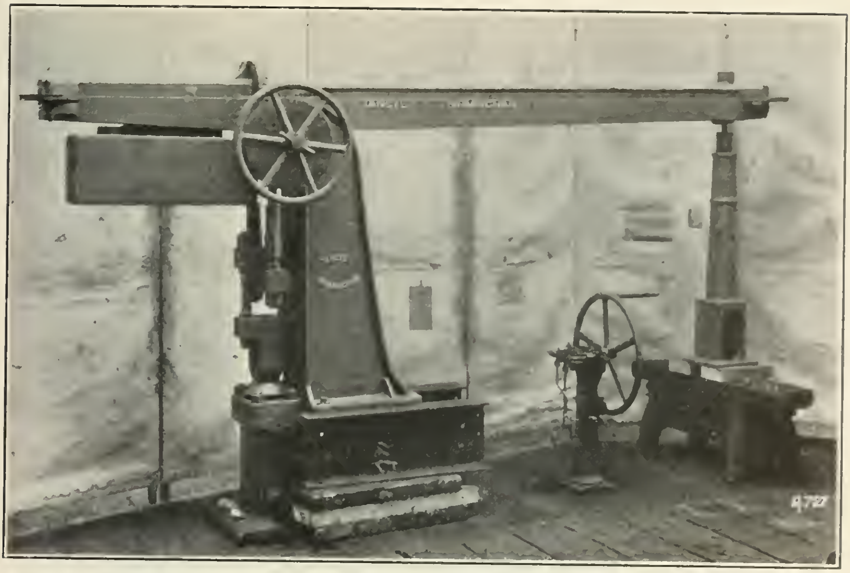
SELF-CONTAINED INVERTED HYDRAULIC PRESS FOR BROACHING PURPOSES.

Available also for riveting up armatures, pressing shafts, etc.; 10-inch ram, 100-ton pressure. Boomer & Boschert Press Co., Syracuse, N. Y.

In designing water ends for such pumps, it must be remembered that water is nearly incompressible, and when it comes in contact with a solid surface, it presses against the surface in a direction directly normal; there can be no such thing as oblique pressure in water when the water is at rest, for oblique pressure means a force partly along the surface, and this would imply some frictional resistance to sliding, which cannot occur in water at rest.

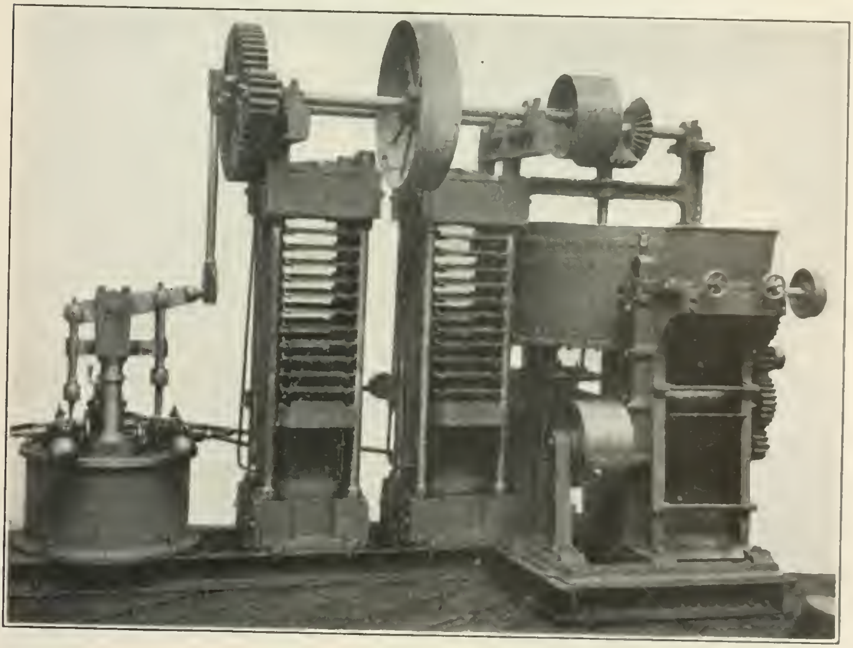
The bursting pressure in a pump cylinder, or in the cylinder of a hydraulic machine, in pounds per square inch, is equal to the tensile strength of the metal in pounds per square inch multiplied by the thickness of the metal in inches, divided by the radius of the cylinder. Water ends made of cast iron usually contain so many hidden defects that with any ordinary working factor of safety they are not really safe when constructed by this rule. For thick cylinders it is difficult to calculate bursting pressures, because the tensile strength is not uniformly distributed over the section at which breakage is likely to occur. For this reason water ends of pumps for high pressures should be made of steel.

Fluid friction need not ordinarily be taken into account in designing hydraulic machinery, because the force of friction depends upon velocity, and is so small at low velocity that it may be wholly disregarded. Also the force of friction does not depend on pres-



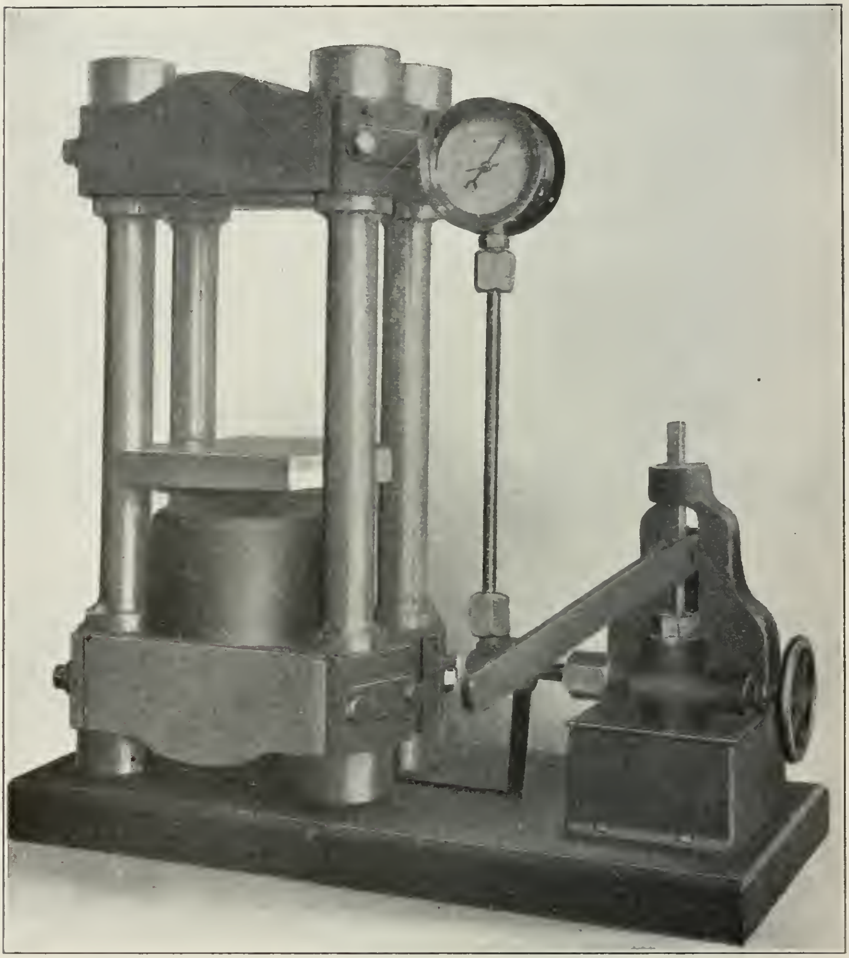
30-TON TENSILE AND COMPRESSION TESTING MACHINE, HYDRAULICALLY OPERATED.

Made for the British War Office, Chemical Research Department, Woolwich Arsenal, by Tangyes, Ltd., Birmingham.



HYDRAULIC PLANT FOR CRUSHING LINSEED, EXPRESSING THE OIL, AND MAKING FEED CAKES

Musgrove Bros., Leeds, England.

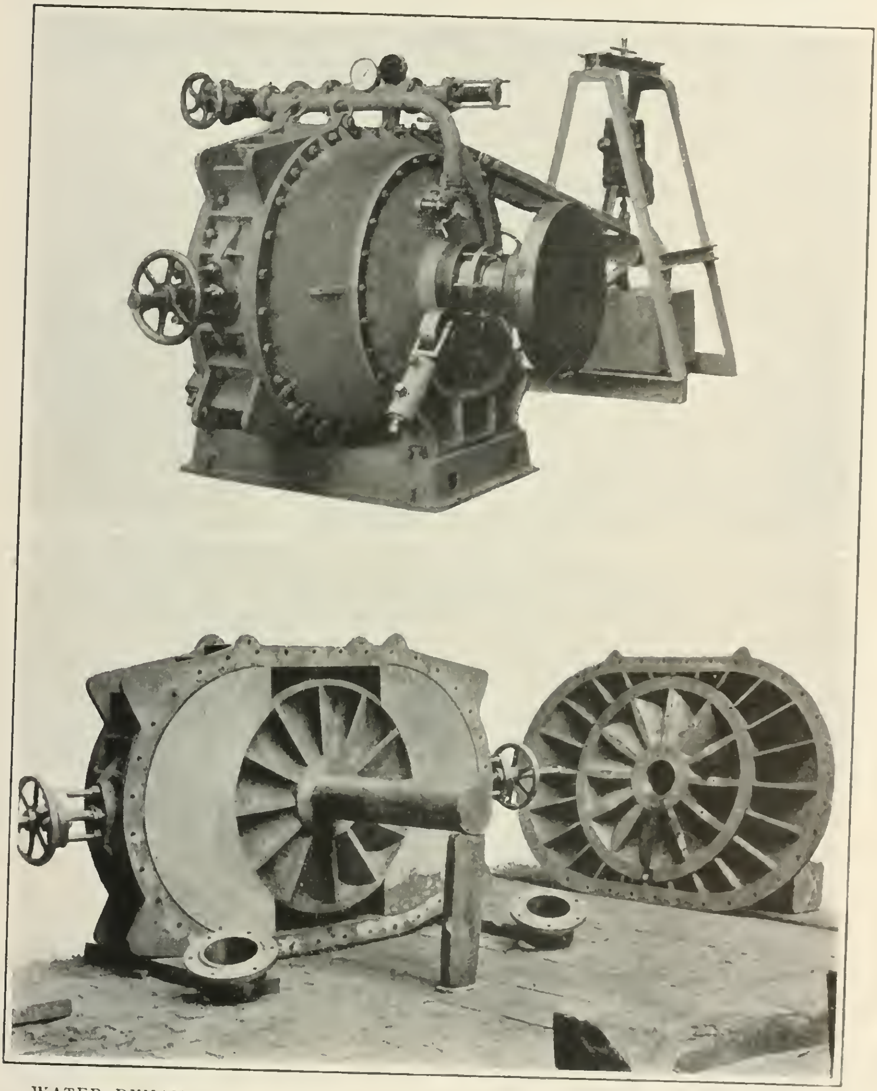


CONCRETE-TESTING MACHINE, CAPACITY 50 TONS IN COMPRESSION.
Ransome Concrete Machinery Co., New York.

sure; it is proportional only to the area of wetted surface, and at moderate speeds does not depend upon the nature of the rubbing surface.

In a hydraulic machine friction must be taken into account, such as that set up between a plunger and a gland, the leather or other packing used in the stuffing box. The friction of solids occurring at the fulcrum of a lever, or that set up between two metal surfaces in contact, must be considered and added to the former. The mechanical advantages of a simple hydraulic machine, leaving friction out of account, depend upon the relative velocities of the plunger and the ram.

Hydraulic machines having simple pressure cylinders are frequently made of a good quality of cast iron instead of cast steel. Breakage seldom occurs in this part of the mechanism, and when it does, it is not a difficult matter to replace a broken part. Hydraulic wheel presses are bored and commonly lined with copper expanded into place and afterwards carefully burnished. The ram is packed with



WATER DYNAMOMETER FOR TESTING ENGINES OF 1,600 TO 2,000 HORSE POWER AT 250 REVOLUTIONS.

Said to be the largest ever made for the work. Heenan & Froude, Ltd., Worcester, England.

cup leather, making a tight joint under pressure, working with little friction and durable as to wear. Such presses exert 100 to 300 tons total pressure, and are commonly fitted with a double pump to save time in despatching work. Both pumps are operated by a single crank and connecting rod for operating the ram rapidly, or for light pressures, but when the pressure becomes too great for both pumps, the large one may be instantly disconnected without stopping the movement of the ram, which, being thus driven by the small pump alone, goes on with the full power of the machine to the maximum pressure.

INTERIOR OF HYDRAULIC-PRESS ROOM IN A WOOD-PULP MILL.

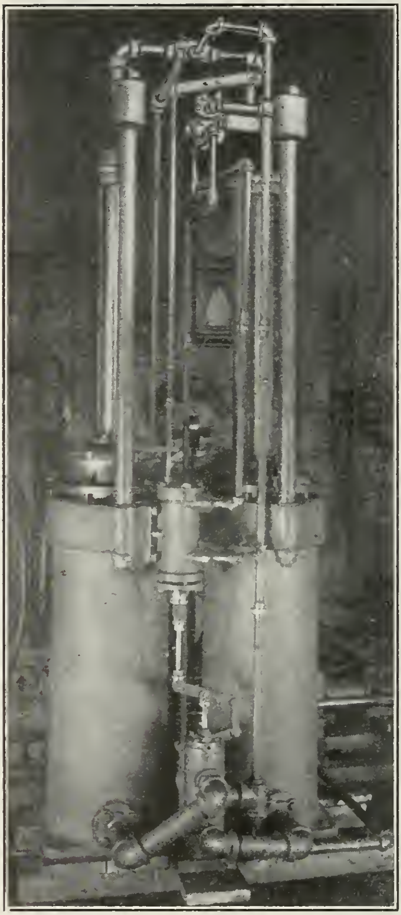
The presses have rams 18 inches in diameter, with rods of 5½-inch forged steel; their regular working pressure is 450 tons. The water is pressed from the pulp as it comes from the machines to save freight in shipment. Boomer & Boschert Press Co., Syracuse, N.Y.

Simple accumulators which consist of a ram carrying a heavy weight are employed for pressures up to 1,500 pounds per square inch. Those having a ram say 3 to 6-inches diameter, consisting of a base plate on which is mounted a vertical pipe with a stuffing box at its upper end into which is fitted a ram with crosshead carrying cast-iron weights, are not only self-supporting but may have as many weights as are necessary for any given pressure. The stroke varies ordinarily from 3 feet for the 3-inch ram to 6 feet for the 6-inch ram.

PRESS SHOP OF THE BETHLEHEM STEEL WORKS, SHOWING ACCUMULATORS AND PRESSURE PUMPS

Larger accumulators are commonly fitted with a tank attached to the upper end of the ram in which scrap or pig metal is placed until the desired water pressure is secured. In extended systems such as steel works, etc., the pressure varies according to the class of machinery employed; the pressure at the accumulator is seldom below 600 pounds per square inch and not often more than 1,500 pounds.

Varying pressures in hydraulic machines can be had by employing two or more pressure lines, one line having its accumulator weighted for the lowest pressure, the other line having its accumulator weighted for the higher pressure. The latter is applied at the moment when the initial pressure is about completing the movement of the ram. The higher pressure should always be applied before the ram actually stops. No difficulty is experienced in thus changing pressures if a suitable valve is employed, because when the higher pressure is applied, the inlet valve for the lower pressure ceases to lift from its seat, the rise of the accumulator taking care of the water flowing into that particular line from the pump.

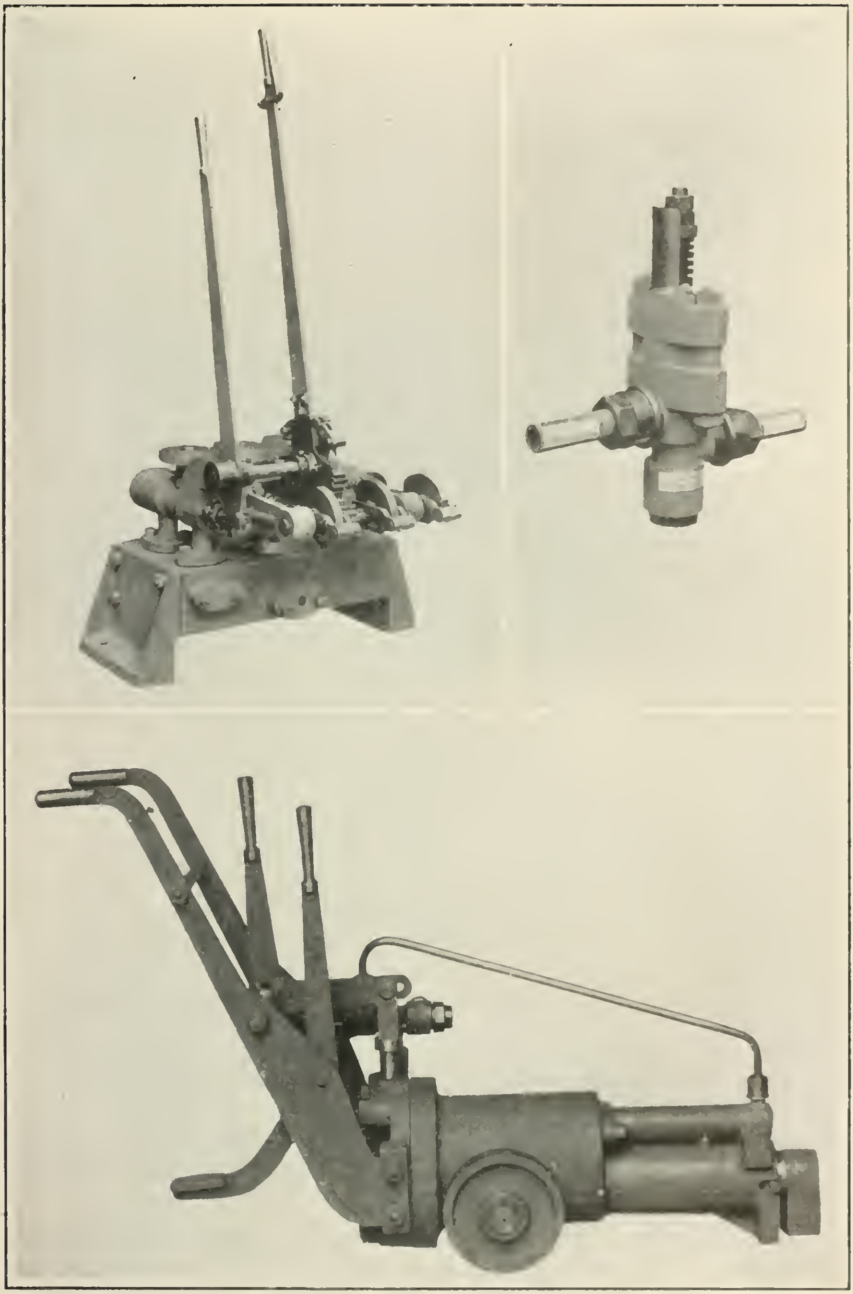


DUPLEX INTENSIFIER.

The Watson-Stillman Company, New York.

In machines operating under two pressures in which the movement of the ram when finishing its stroke is small, a final pressure of several thousand pounds per square inch can be had by means of an intensifier, a machine which consists essentially of a large cylinder fitted with a piston and a small cylinder fitted with a ram corresponding to an ordinary piston rod. The large cylinder, being filled with any fluid under pressure, will exert an increased pressure in the small cylinder corresponding to the difference in areas of the piston and the ram. For example, a cylinder 12-inches diameter with a pressure of 300 pounds per square inch acting upon a second ram of 4-inches diameter would exert a pressure of 2,700 pounds per square inch, this representing the ratio of differences of area into the initial pressure.

An intensifier is sometimes used in connection with a riveting machine, taking the place of a weighted accumulator; in which case the pump delivers into the high-pressure end of the machine, the opposite end being in connection with a steam boiler, city-water main,

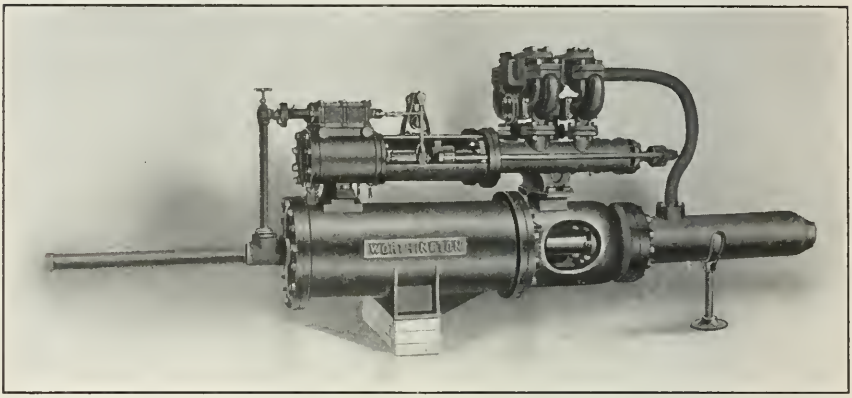


A GROUP OF HYDRAULIC APPLIANCES.

Above on the left is a set of hydraulic actuating valves for a pressure of 3 tons to the square inch. To the right, a hydraulic reducing valve for testing purposes in shops where various pressures are carried. At the bottom is a portable angle-bending machine for use in shipbuilding yards. The Leeds Engineering & Hydraulic Co., Ltd., Leeds, England.

or other constant supply at practically unvarying pressure; this, however, is not the usual practice.

Steam accumulators can be used in connection with a steam pump delivering directly into the cylinder of a hydraulic machine. Suppose a boiler pressure of 100 pounds per square inch and a steam pump delivering water into a hydraulic cylinder at 250 pounds per square inch, pressure enough to do the earlier stages of the work; now by admitting the above steam pressure directly into the cylinder of an accumulator, a final pressure would be exerted at the delivery of the ram cylinder in proportion to the difference in areas:—thus, a 16-inch steam piston with 3-inch ram would exert a pressure of 2,800 pounds per square inch in the cylinder of the hydraulic machine. To keep the steam at constant pressure in the cylinder a reducing valve should be used, and set at some pressure less than that of the steam boiler.

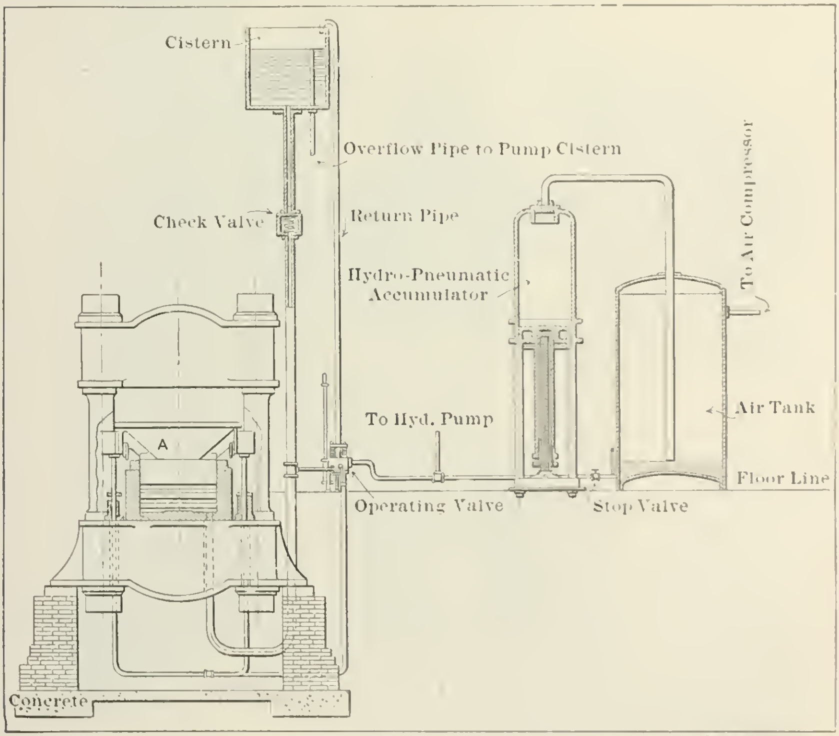


A WORTHINGTON STEAM ACCUMULATOR.
Henry R. Worthington, New York.

A hydro-pneumatic-press operating system is shown in connection with a 2,500 ton press, the ram being 36-inches diameter by 11-inches-maximum stroke, the average working stroke being about 4 inches under the low pressure and about ½ inch under the final pressure. All the working parts are shown except the pump. The working of the press is as follows:—

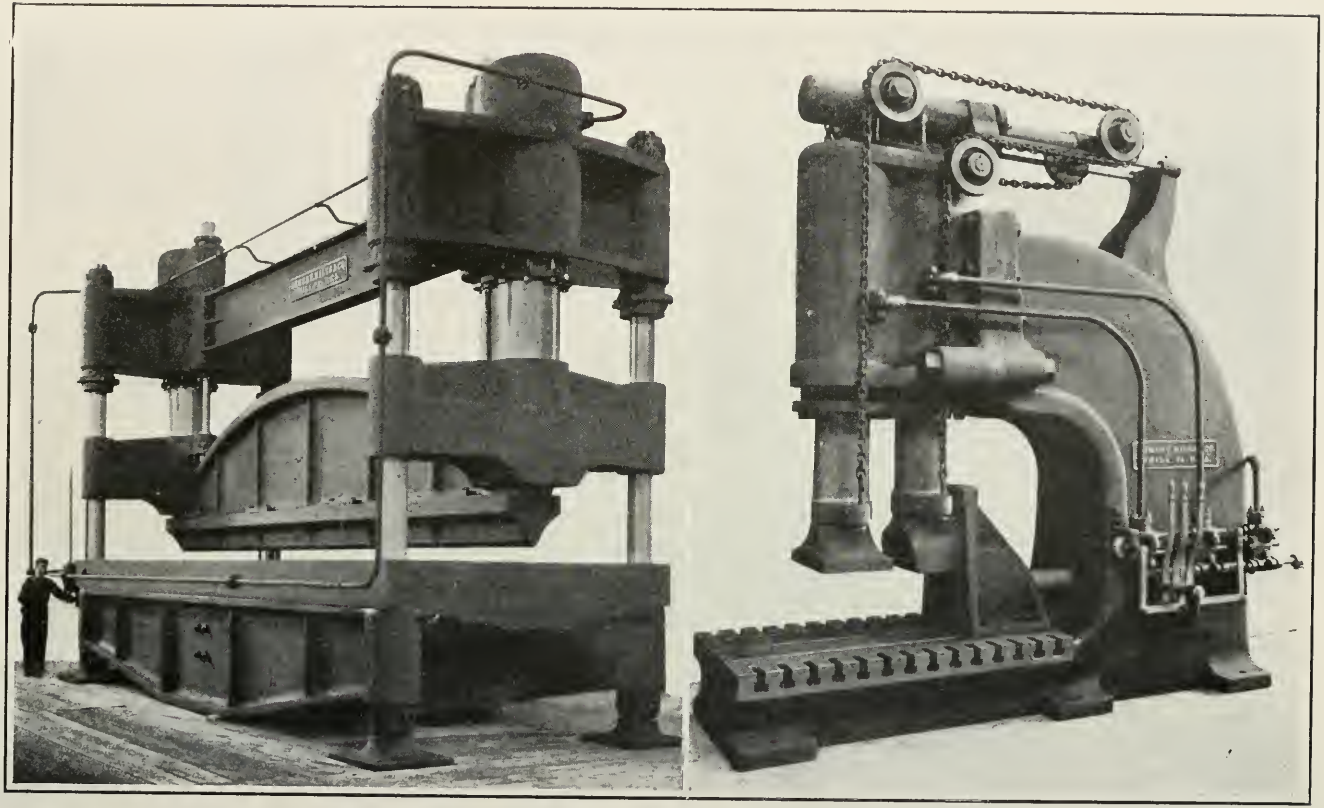
It having been determined what pressure the work requires, the air pressure is pumped up in the air tank to such a point that the product of the ratio of area of press ram and high-pressure end of the intensifier by the low-pressure end and the air pressure shall equal the desired pressure. Then the raising of the low-pressure valve piston permits water from the gravity tank to flow direct to the press, the reversing cylinder being at the same time relieved of strain, raising the press platen up to the work proper. The power pump having forced the intensifier piston to the top of its stroke, the raising of the hydraulic pump-valve spindle permits the air from the air tank to force the intensifier piston down and exert at once the pressure desired, a check valve in the gravity-tank pipe preventing the water flowing to that point. There are small cylinders on the press for reversing or drawing the platen down and raising the water to the gravity tank. When the main valve is reversed, the liquid in the press cylinder goes upward to the gravity tank, and from there the overflow goes to the pump reservoir, when it is ready to be pumped to the hydraulic-pump side of the intensifier.

The hydraulic pump runs continuously except when cut out by the intensifier reaching the top of its stroke. The air pump is to be run only a short time each day to fill up the loss from absorption, which is very little as the system is a closed one. Small valves are provided to cut off the air tank or to permit water to be forced into it, if necessary. To have this system work properly, it is easy to see



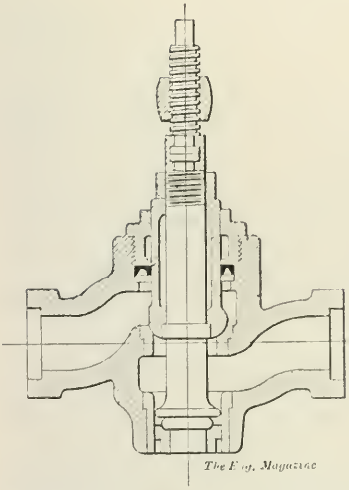
HYDRO-PNEUMATIC PRESS-OPERATING SYSTEM.

The Watson-Stillman Co., New York.



SOME TYPICAL AMERICAN HYDRAULIC MACHINES.

That on the left is a garboard-bending machine, made 24 feet 8 inches by 8 feet between posts, with a maximum effective pressure of 450 tons. That on the right is a universal hydraulic flanging press, the two vertical pistons each having a stroke of 30 inches with a pressure of 75 tons, and the horizontal one a stroke of 24 inches with a pressure of 20 tons. Both are by the Niles-Bement-Pond Co., Bement shops, Phila., Pa.



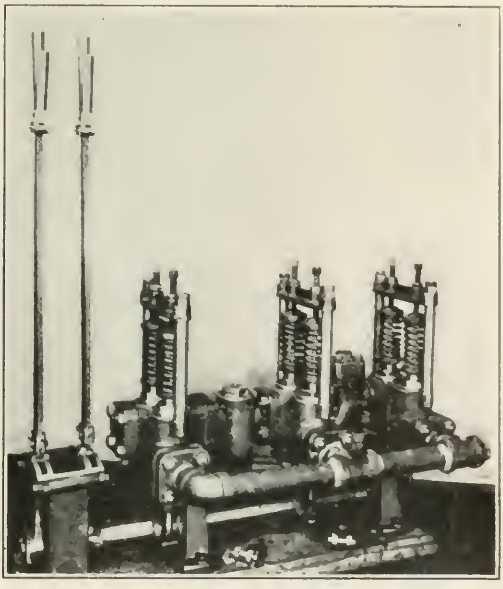
WATSON-STILLMAN BALANCED-SPINDLE STOP VALVE.

that it must be all designed to work together, and two presses calling for different pressures cannot be used at once.

Water being practically incompressible, a sudden stoppage of flow, as in the case of a rapidly falling accumulator, means a very severe impact in the pipes, and breakages are liable to occur. For this reason relief valves are provided. A curious thing about a relief valve is that it is not a valve at all, but simply a piston fitting into a bored cylinder and having a heavy spring above it which is sufficiently in tension to prevent compression under all working conditions, but which yields under sudden impact, thus preventing breakage of pipes, fittings, or pump valve chambers.

Balanced-spindle stopvalves are a necessary detail in any hydraulic system in which there is more than one machine connecting with a pressure-pipe-line. The valve illustrated has been made in sizes up to 6 inches in diameter operating under 2,500-pounds pressure per square inch; the valve is perfectly balanced except for the small area in contact at the seats.

The universal hydraulic flanging press opposite is designed to do a variety of flanging work with comparatively few dies. The two vertical pistons each exert 75-tons pressure and have 3-inches stroke; the horizontal piston exerts a pressure of 20 tons and has 24-inches stroke. The maximum distance between the vertical pistons



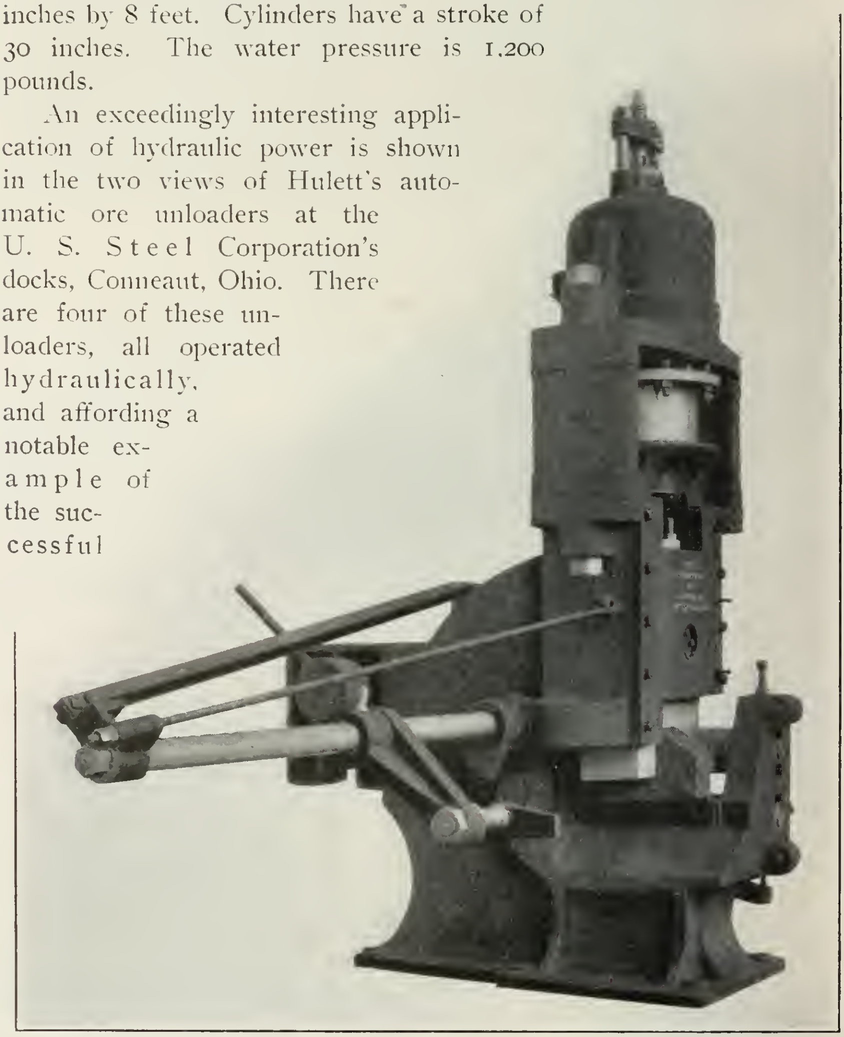
A SET OF 2-INCH BALANCED-SPINDLE HYDRAULIC-PRESS AND INTENSIFIER GOVERNING VALVES.

The Watson-Stillman Co., New York.

and the table is 42 inches. All the pistons are returned by hydraulic drawback cylinders. The water pressure is 1,500 pounds per square inch.

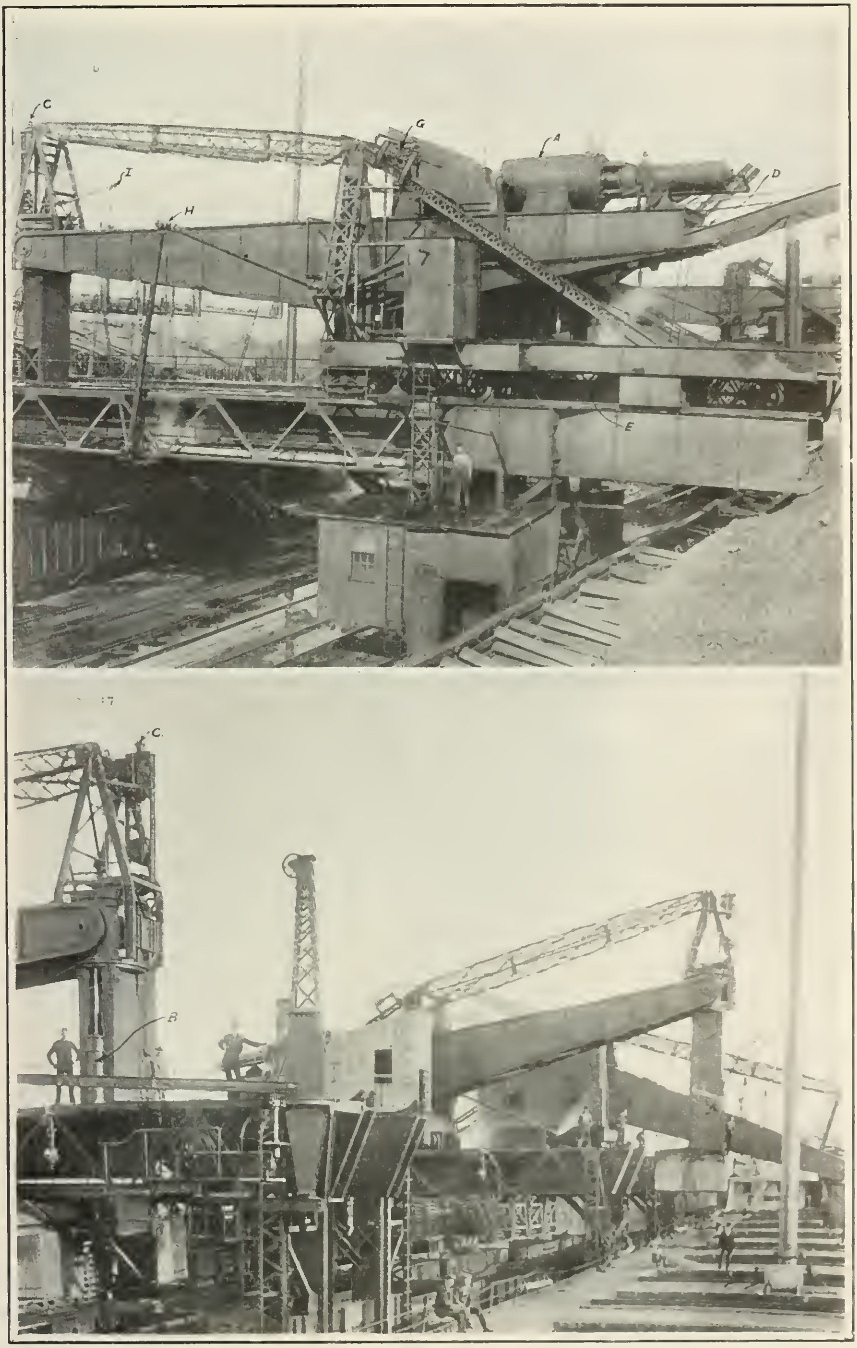
A garboard bending machine designed for bending keel plates, garboard strakes, sponsons, and miscellaneous irregular plate work is shown on page 832. The maximum effective pressure is 450 tons. Both ends of the bending beam may be operated together or either end independently. The usual length of the beam is 26 feet 5 inches; the usual clear distance between the posts is 24 feet 8 inches by 8 feet. Cylinders have a stroke of 30 inches. The water pressure is 1,200 pounds.

An exceedingly interesting application of hydraulic power is shown in the two views of Hulett's automatic ore unloaders at the U. S. Steel Corporation's docks, Conneaut, Ohio. There are four of these unloaders, all operated hydraulically, and affording a notable example of the successful



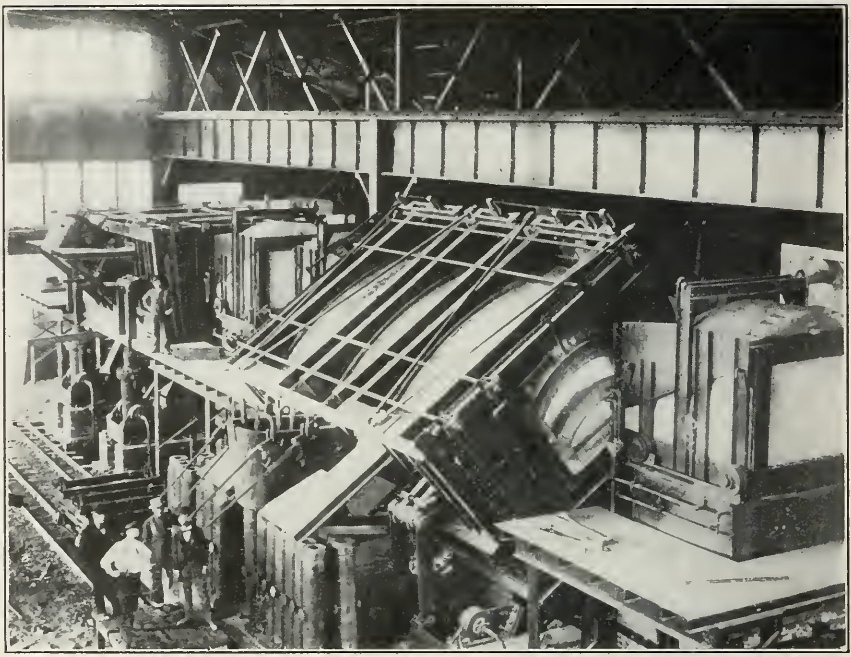
HYDRAULIC BILLET SHEAR, WATER PRESSURE 750 POUNDS PER SQUARE INCH.

United Engineering & Foundry Co., Pittsburg, Pa.



TWO VIEWS OF THE HULETT ORE UNLOADER AT WORK AT THE CONNEAUT DOCKS, OHIO.

Built by the Wellman-Seaver-Morgan Co., Cleveland, Ohio.



ROLLING OPEN-HEARTH STEEL FURNACES, HAMILTON STEEL & IRON CO. TILTED BY HYDRAULIC POWER.

Built by the Wellman-Seaver-Morgan Co., Cleveland, Ohio.

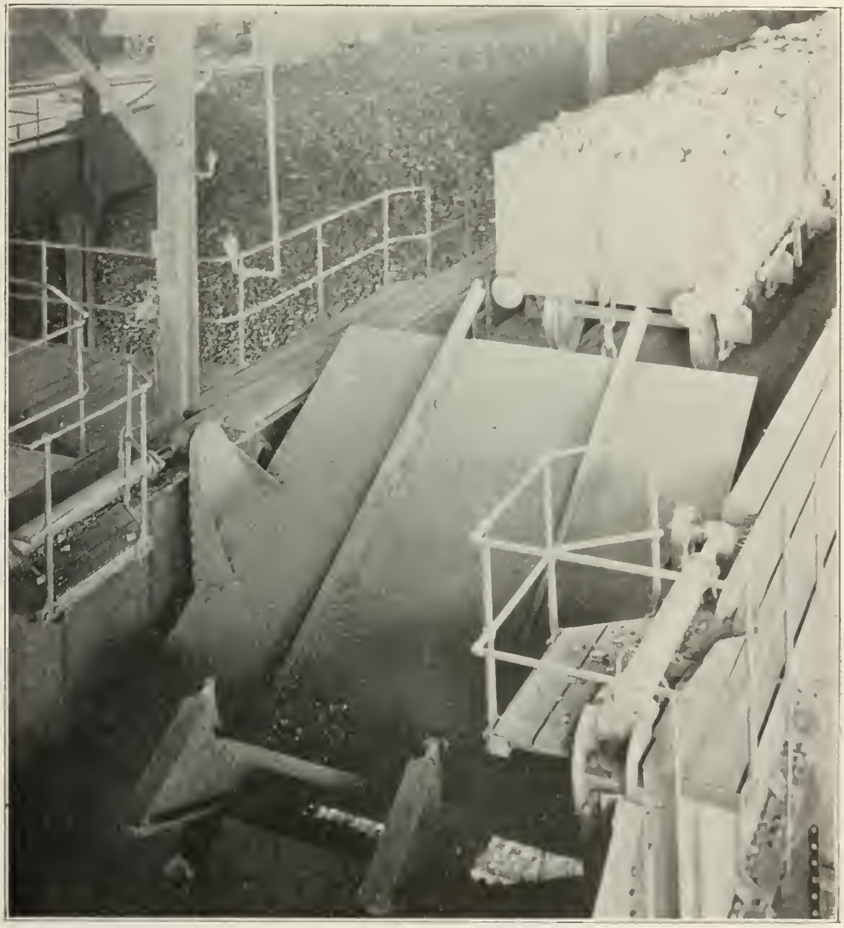
application of hydraulic power to extremely severe and heavy work.

The walking beam carries a dependent leg, with an automatic grab bucket which holds 10 gross tons of ore, scooping up the ore from the hold of the vessel, and carrying it back over the dock where it is discharged into railroad cars.

The use of hydraulic power for tilting a steel furnace is a somewhat novel application in hydraulic engineering. The cut above represents two Wellman patent rolling open-hearth furnaces at the Hamilton Steel and Iron Company, Hamilton, Ont., in which one furnace is shown tilted to the pouring position. The rolling movement of each furnace is accomplished by two hydraulic cylinders mounted on trunnions at their lower ends, and having the upper ends of their piston rods attached to the pouring side; to tilt the furnace, water is admitted to the top end of the cylinder.

Ordnance engineers have applied hydraulic mechanism to gun carriages with great saving in labor, together with greater rapidity of discharge. As compared with electrical equipment, the hydraulic mechanism is preferred—amongst other reasons, because with the severe shocks which are experienced in firing heavy guns there is less likelihood of the massive built hydraulic mechanism being injured than would be the case with electric gear; and, in the event of slight damage resulting, its existence and location are at once discovered, owing to water leakage. The water pressure commonly used for this purpose is 1,000 pounds per square inch.

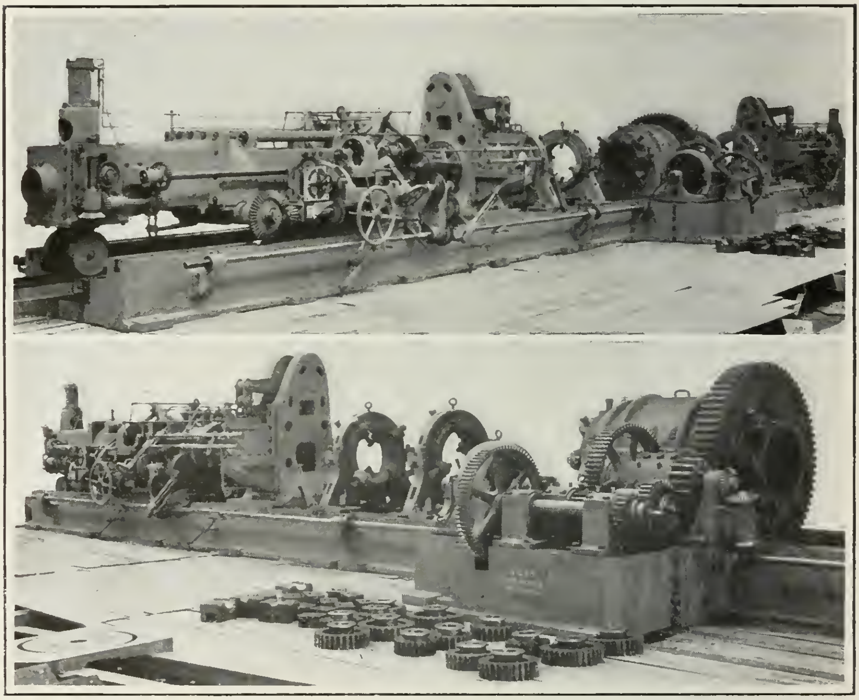
Engine lathes for boring and cutting off steel ingots are now adapted with hydraulic feed to the boring bench. The boring bar is held securely in and carried by a hollow piston which forms a part of



HYDRAULICALLY OPERATED COAL-WAGON TIPPING PLATFORM.

Hydraulic pistons, moving horizontally the trunnions carried on the side brackets, cause the platform to roll on rockers below. Sir Wm. Arrol & Co., Ltd., Glasgow.

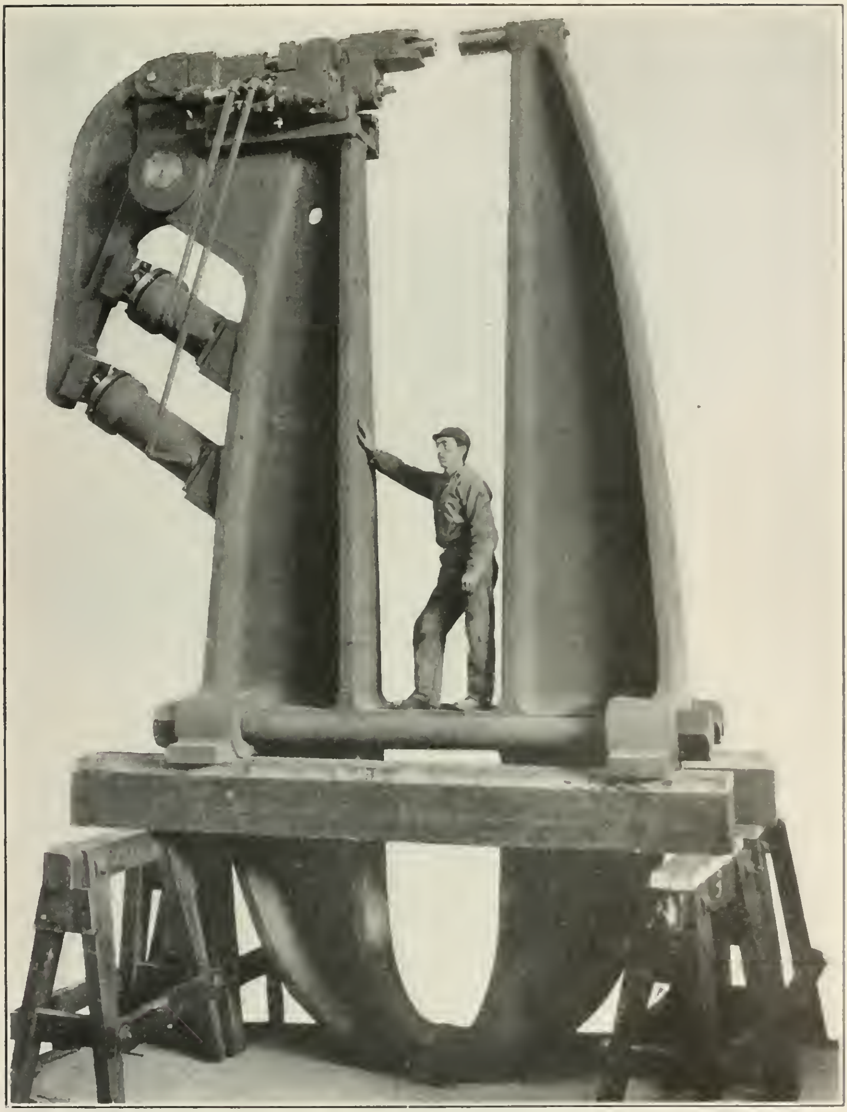
the boring feed device; end pressure is given the boring bar through an accumulator acting on the piston in a hydraulic cylinder which is, of course, in excess of the requirements of the cutting tool. This end pressure is resisted by a revolving nut engaging with an elongation of the piston, the nut being placed between end thrust bearings. The amount of feed is determined by the rotary motion given to the nut. This device forms an escapement system entirely free from any possibility of the boring tool jumping forward and hanging in the ingot.



HYDRAULIC BORING LATHE, FOR GUN FORGINGS, MARINE SHAFTS, AND LARGE INGOTS GENERALLY.

Takes in a shaft 60 feet long, 30 inches diameter, and bores a hole 12 inches diameter the full length, or 14 inches for short lengths. Two boring bars, fed by hydraulic pressure, are used, one from each end. Pressure 720 lb. per square inch, giving a total of 200,000 lb. against the piston; driven by a 100-horse-power motor; change gears and friction discs give a wide range of speeds; handles for operating the various valves are placed both at front and rear. The Niles-Bement-Pond Co.

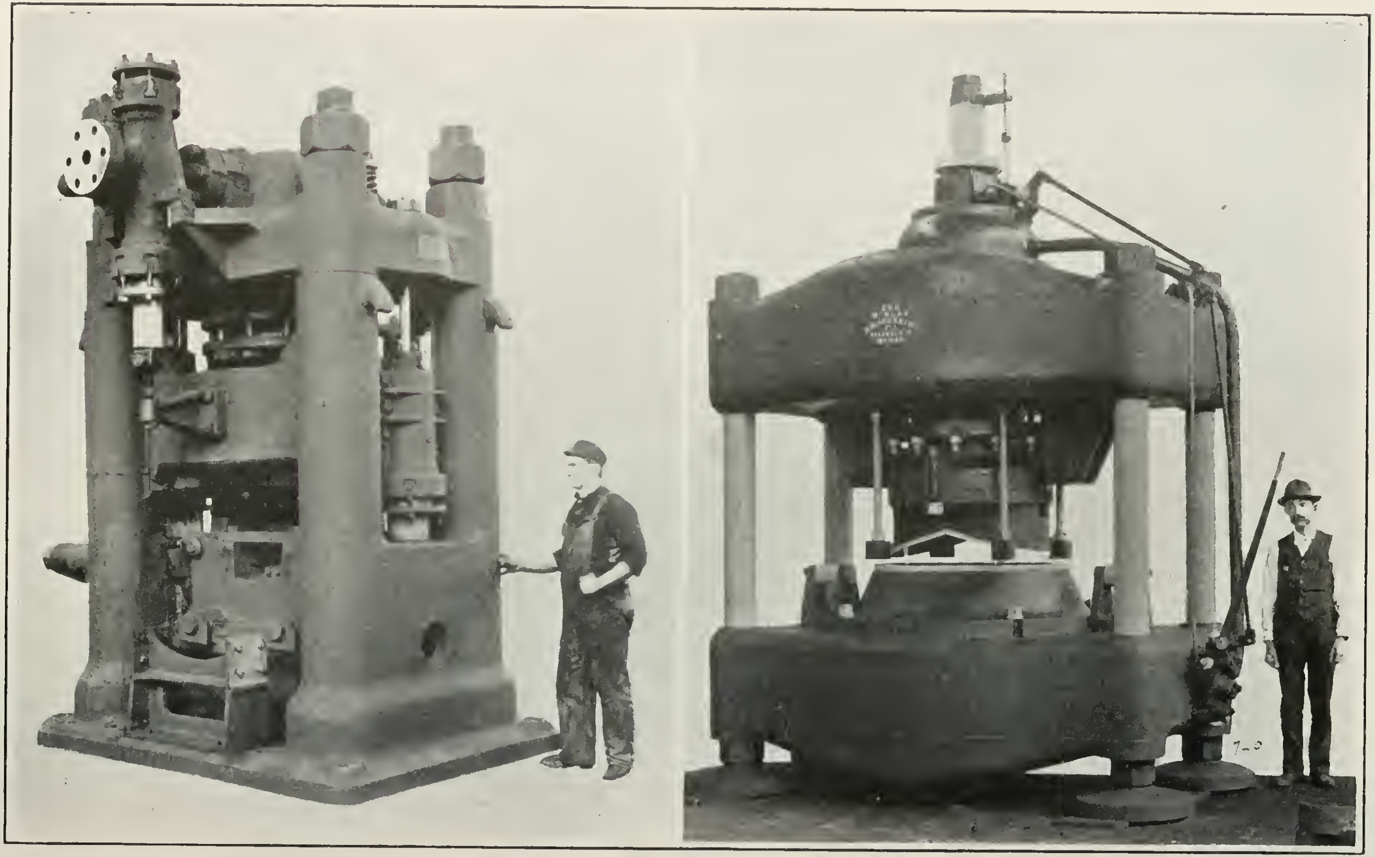
Hydraulic punching and shearing machines are now in very general use in ship yards, large boiler shops, structural steel works, etc. The one illustrated on the facing page has 12-feet depth of throat, and is arranged to give three separate pressures on the dies—50, 100, or 150 tons, with water pressure at 1,500 pounds. This is secured by operating the ram, through the lever, by either one or by both of the cylinders on the back of the frame.



A LARGE HYDRAULIC RIVETING MACHINE. THE THROAT IS 12 FEET DEEP.

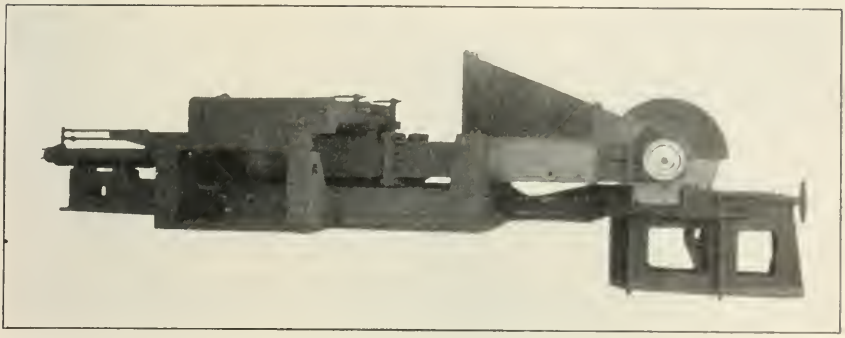
Gives three separate pressures upon the dies—50, 100, and 150 tons with 1,500 lb. water pressure. The ram is operated by one or other or both of the cylinders on the back of the frame.
Wm. Sellers & Co., Inc., Phila., Pa.

As compared with a power-driven machine in which there is a large and heavy flywheel and a train of gears, if a hydraulic machine can do the work, it is, in general, to be preferred. For example:—if a piece of material be placed between a punch and die, or between the



HEAVY SHEARS AND PUNCHES OPERATED BY HYDRAULIC PRESSURE.

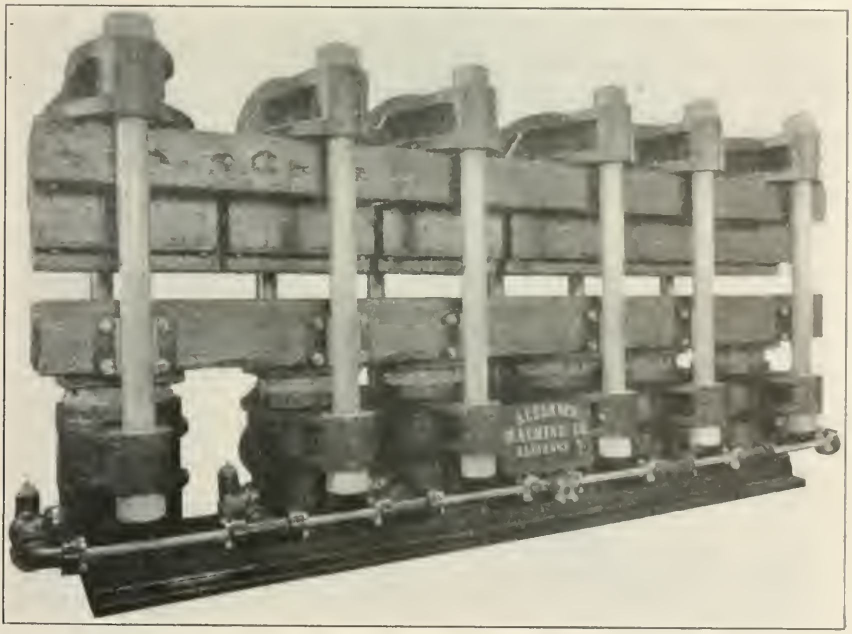
The machine on the left is a hydraulic beam shear, built by the United Engineering & Foundry Co., Pittsburg, Pa., working at a water pressure of 1,500 lb. per square inch. That on the right is a hydraulic manhole punch; it is designed and built by the Morgan Engineering Co., Alliance, Ohio.



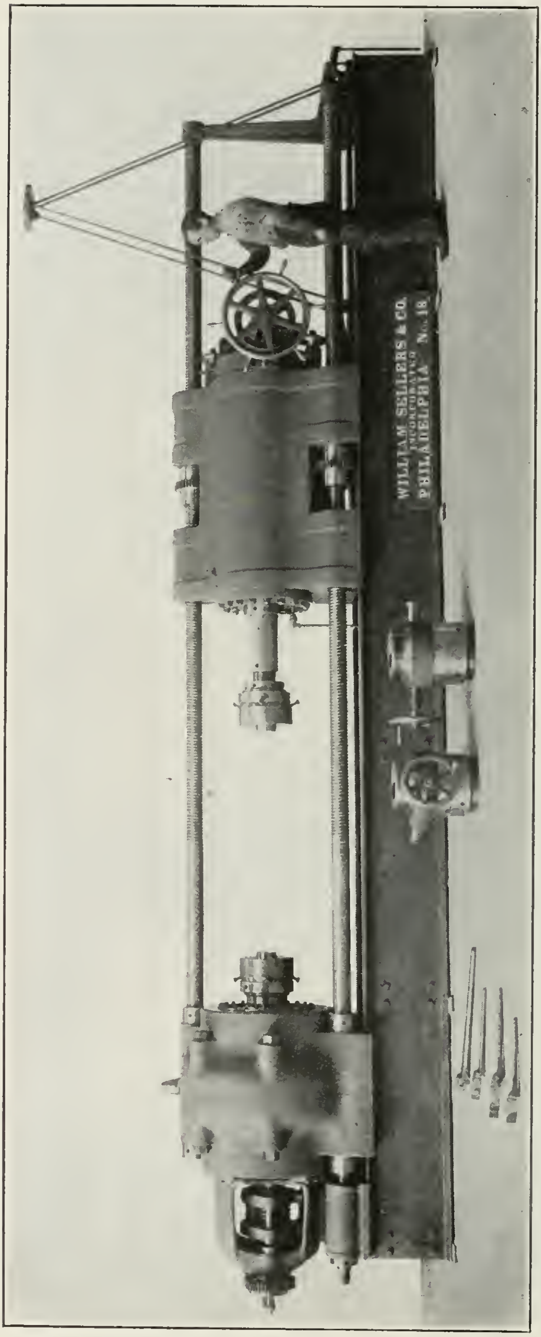
HIGH-SPEED COLD SAW WITH HYDRAULIC FEED AND OIL CYLINDER FOR CHECK.
United Engineering & Foundry Co., Pittsburg, Pa.

blades of a shear requiring greater capacity than the geared machine was designed for, destructive strains would be set up in the machine which would probably result in breakage; whereas in the case of a hydraulic machine the plunger would simply come to a standstill and remain thus without doing any harm whatever.

Another advantage in the application of hydraulic power to a punch and shear is that power is consumed only when in use, the ma-

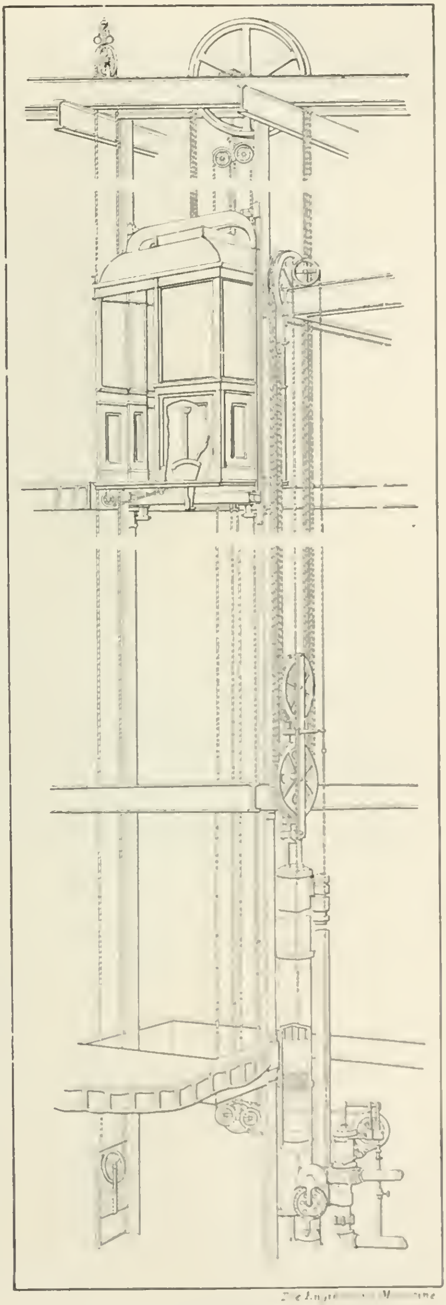


SIX-CYLINDER HYDRAULIC PRESS FOR VERY LONG SHAPES.
Gives three pressures, the cylinders being coupled in pairs so that any pair may be cut out.
Alliance Machine Co., Alliance, Ohio.



chine has few wearing parts, the load is always definite in amount and cannot be increased, and, when properly designed, destructive strains are never set up while in use, because the pressure is a fixed quantity. The element of time is one not to be overlooked in heavy punching and shearing; the hydraulic permits, as no other system does, the separation of the particles of metal in a straight line between the punch and die or between the shear blades.

Hydraulic elevators are so largely used in office buildings, apartment houses, hotels, etc., that their adoption as a means of communication between different levels is greater than that of any other system. The construction mostly in use consists of a cylinder and piston with suitable valves for the admission of water on either side of the piston, and providing for the discharge of



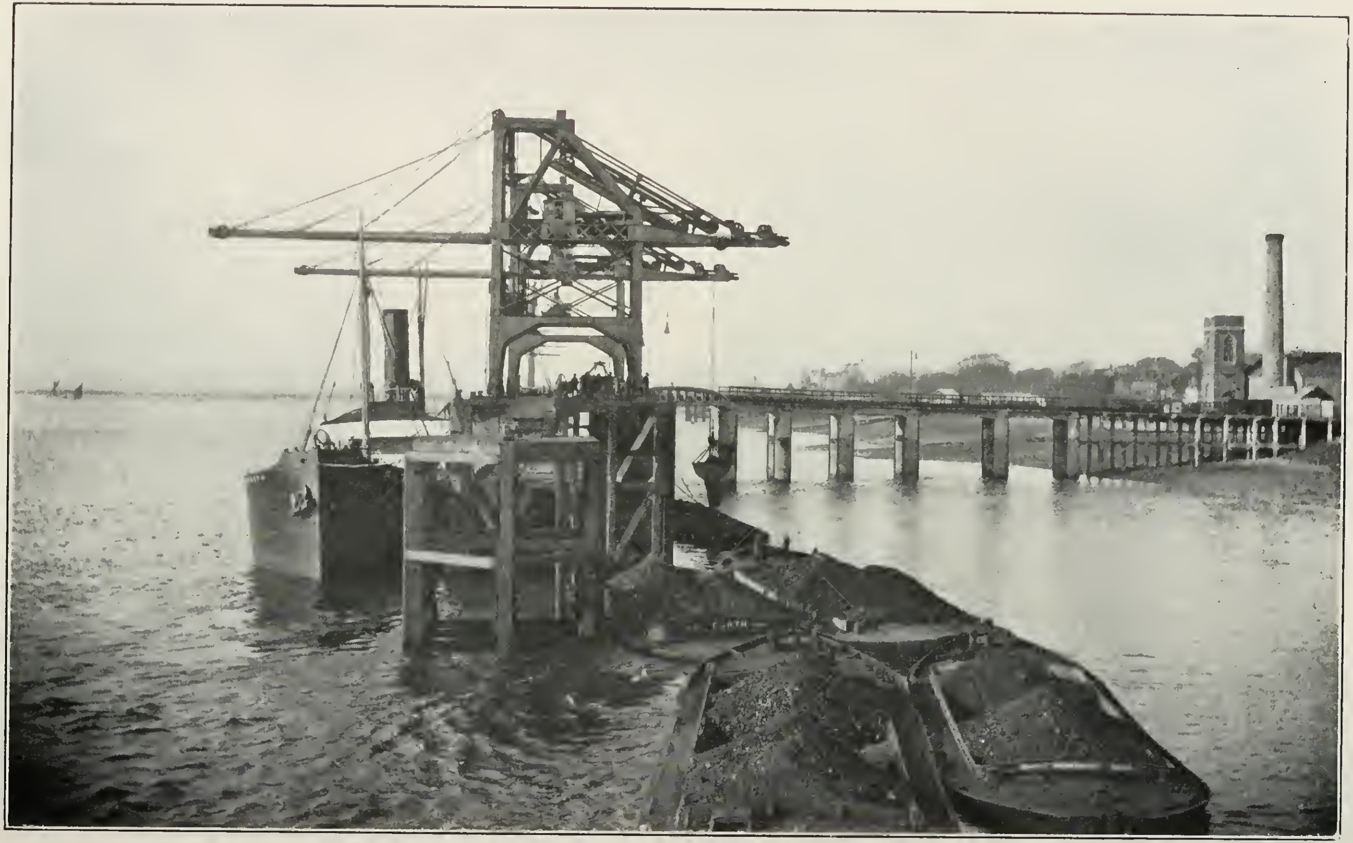
The Engineering Magazine

SCHEMATIC OUTLINE OF HYDRAULIC ELEVATOR.

water from the cylinder end opposite to that of the entering water. One or more piston rods attached to the piston pass through stuffing boxes in the cylinder and are secured to a crosshead, which operates the car by means of wire ropes. These lifting ropes pass over sheaves by which any degree of multiplication of speed can be secured, ranging from four to one up to twelve to one; that is, the car travels in the latter case twelve times as fast as the piston. The cylinders may be vertical or horizontal as will best suit the local conditions.

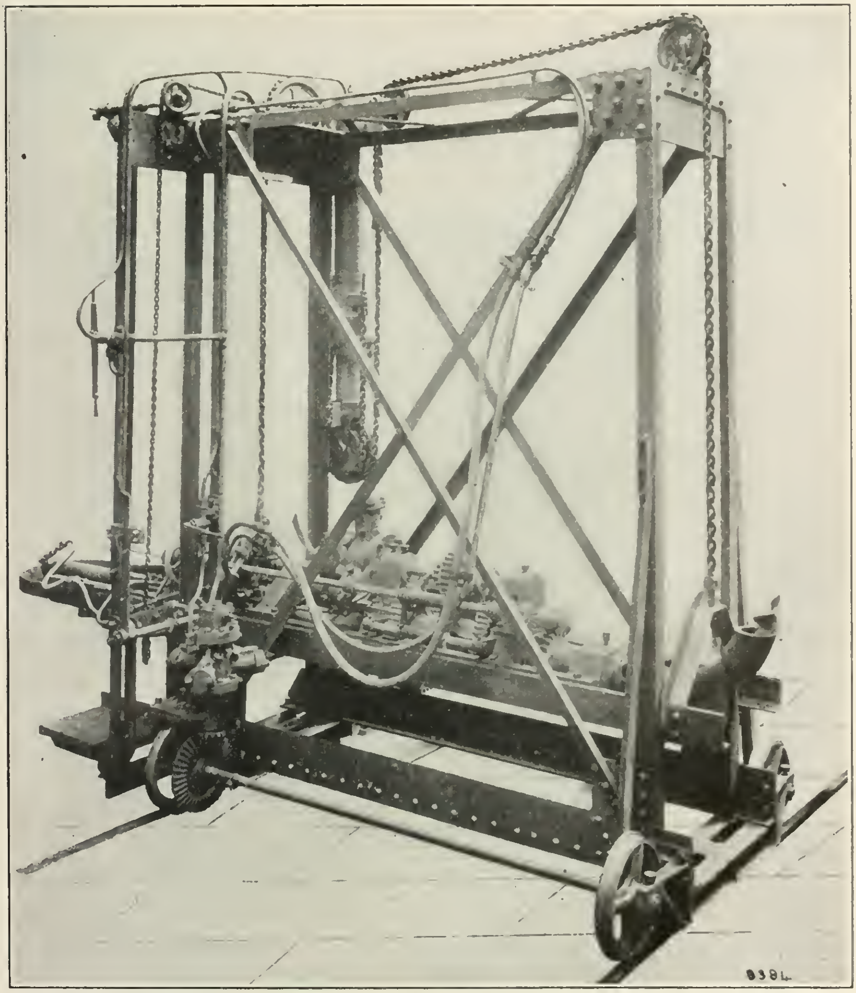
The speed of the elevator car in buildings of five or six stories is generally about 150 feet per minute, but in high office buildings the speed is about 400 feet per minute. The control of the elevator is always from the car, and this requires in the case of high speeds a device for operating the valves which shall operate quickly, but without producing a jar or other disagreeable sensation in the car.

Hydraulic cranes were at one time in a fair way of general application and adoption, but the present trend is towards the electric system. The principal defect in hydraulic cranes lies in the use of chains passing over numerous sheaves, giving



TWO HYDRAULIC TRANSPORTER CRANES ERECTED FOR THE STEAMSHIP OWNERS' COAL ASSOCIATION, LTD., AT THEIR NEW CONCRETE-STEEL PIER, PURFLEET, ESSEX.

Each is capable of delivering more than 70 tons of coal per hour from steamer to barge. Designed and erected by Sir W. G. Armstrong, Whitworth & Co., Ltd.

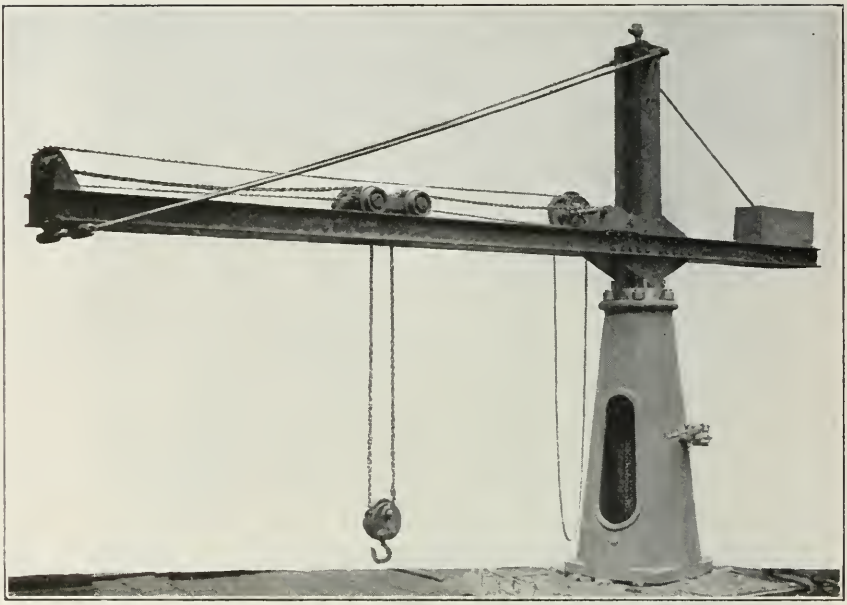


HYDRAULIC DEVICE FOR CLEANING THE ASCENSION TUBES OF GAS RETORTS.

The cleaning tool is brought to the mouth of the retort, pushed up the ascension pipe by a hydraulic cylinder, and rotated by a hydraulic motor carried on the rising and falling beam; all controlled by one man on the platform on the left. Sir Wm. Arrol & Co., Ltd., Glasgow.

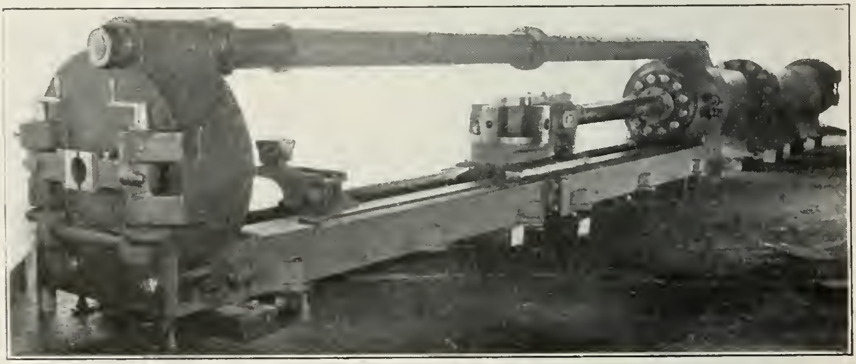
rise to a great amount of friction, and in the fact that as much energy is consumed in lifting a light load as if working up to the maximum limit. In exposed situations hydraulic cranes are liable to freeze fast during the winter months, unless carefully protected from a cold atmosphere, which is not always convenient.

On the other hand, it has been pointed out previously in these pages, especially in the articles by Mr. E. B. Ellington, in June,



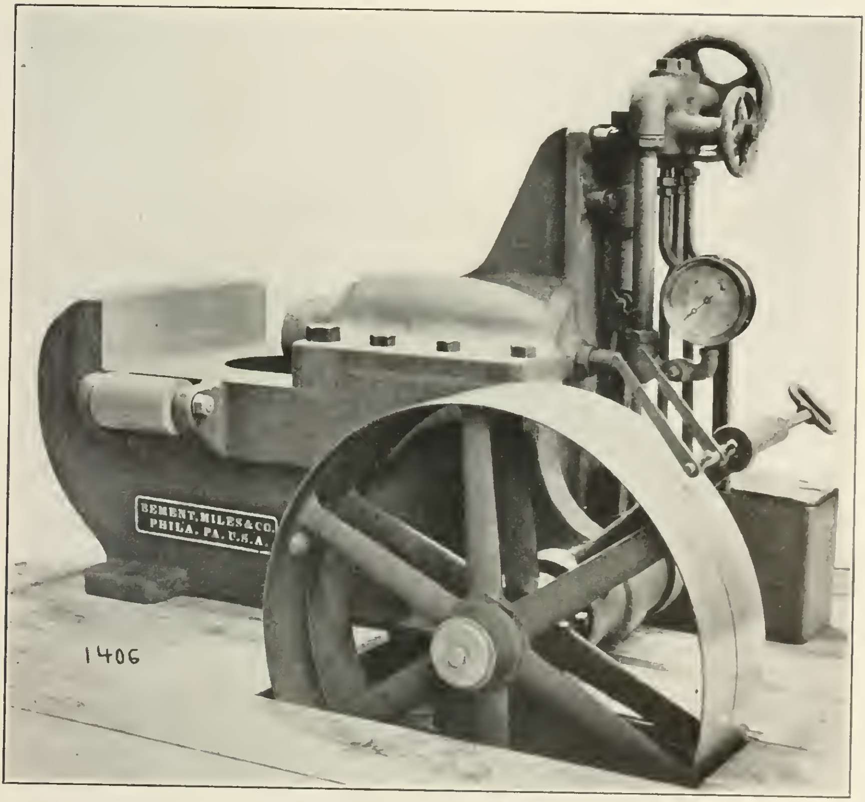
SELF-CONTAINED HYDRAULIC YARD CRANE.
Musgrove Bros., Leeds, England

1899, and by Mr. George H. Baxter, in March, 1904, that hydraulic power in this connection stands quite alone and apart from all other systems of power application in virtue of its pressure being applicable directly to the lifting appliance, without the intervention of any gearing or other mechanism. On this account its advocates plead its claims to absolute safety, simplicity of construction, certainty of control, and freedom from reliance on brakes. They also point to its



HYDRAULIC PUSH BENCH, FOR DRAWING LARGE COPPER OR BRASS TUBES OVER AN ARBOR OR PUNCH.

perated at 2,000-lb. pressure from a pump or 1,000-lb. from an accumulator system. Floor space 47 feet 9 inches by 4 feet 2 inches; cylinder 18 feet by 18 inches. Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

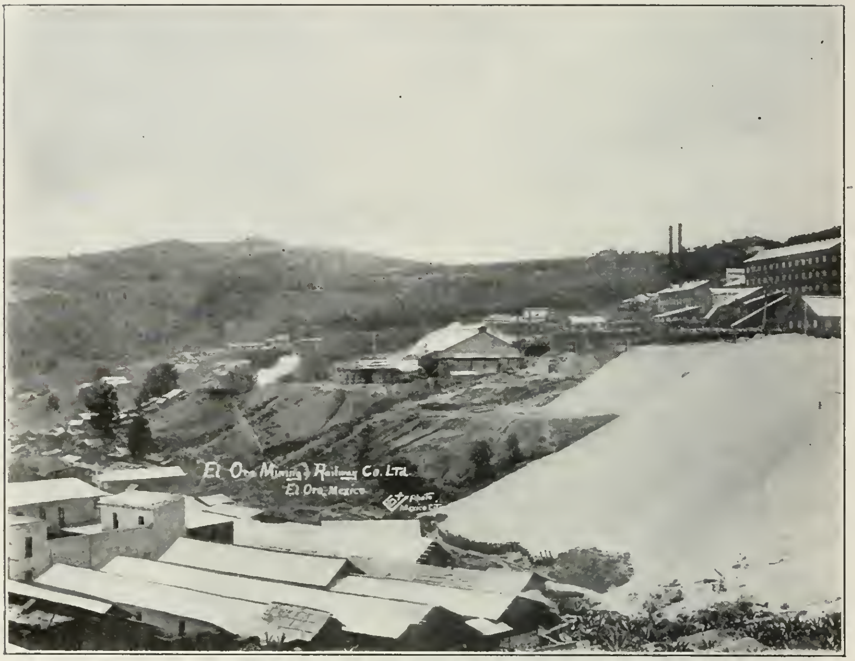


A HYDRAULIC RAIL-BENDING MACHINE.

Capable of bending rails up to 100 lb. per yard in weight; arranged for either belt or electric-motor drive. The Niles-Bement-Pond Co., N. Y.

high efficiency, as high as 95 per cent, when used directly in lifts at full load. It may be freely admitted that for many purposes hydraulic power will remain more suitable than any other form, and at present there are many impressive examples of its use in large crane hoists, especially about the larger shipping ports and docks of Great Britain. One of the latest installations is represented in the illustration on page 844.

The principal advantages of hydraulic transmission of power may be briefly stated to be that, in the case of intermittent work, the accumulator is so nearly perfect in its action that it will always give out energy in proportion to the quantity of water used. It is equally applicable in systems requiring either much or little pressure, large or small volume.



Town, 10,000 pop. | Chihuahua | Cyanide Tanks and Tailings | Carmen Mine | No. 2 Mill 100 Stamps

PANORAMA OF EL ORO. CONTINUED ON THE FOLLOWING PAGES.

ELECTRIC MACHINERY FOR THE OPERATION OF MEXICAN MINES.

By Charles V. Allen.

In a preceding article Mr. Allen outlined generally the part played by electric power in revivifying the mineral industry in Mexico. He follows now with a concrete description of one of the largest and most complete installations—that at El Oro.—THE EDITORS.

MEXICO is one of the richest countries in the world in the production of minerals—first in the production of silver, second in copper, and seventh in gold. It is estimated that since the royal mint was established in 1537, up to 1899, the output of silver in Mexico amounted to about $3,500,000,000 Mexican currency. There is more than $125,000,000 of capital invested in the mines and smelters of the country.

The enormous wealth of the Mexican mines is found more in the large quantity of ore than in its richness. In 1904-05 the production of gold, silver, copper and other metals amounted to $70,200,000. The amount of silver produced is vastly in excess of the gold, this

PANORAMA OF EL ORO. THE TAILINGS PILE CONTAINS 400,000 TONS.

being accounted for by the fact that few gold veins exist, the gold being combined with the silver in most cases. Little attention is paid to placer mining in gold, it having proved impracticable on a large scale. The early mining was naturally surface work, resulting from the finding of outcroppings of very rich ores, and camps such as Pachuca, Guanajuato, Zacatecas, etc., now show these old surface workings. The early method of mining was to dig into the side of a hill, or downward, until water was struck, when the working would have to be abandoned for lack of contrivance to remove the water. A crude Mexican hand-operated pump, used somewhat in later days, consisted of a raw-hide rope passed over a large wooden wheel, to which was attached an endless chain of buckets, dipping into the water below and emptying into a trough over the side above as the wheel revolved. A number of short sticks were knotted into the rope engaging the wooden crossarms on the circumference of the wheel to prevent slipping, thus providing a crude sort of rack and pinion.

One of the first methods of crushing ore was by means of *arrastras,* consisting of a wooden framework slowly revolved horizontally,

EL ORO PANORAMA CONTINUED. THE SUB-STATION RECEIVES CURRENT AT 60,000 VOLTS FROM NECAXA, 171 MILES.

to the arms of which were tied large grinding stones. These were dragged in a circle over ore which had been previously broken by hand or in a stamp. They were operated by water power direct, or by mules, in a very crude manner.

The original *patio* process of silver extraction employed barefooted boys; in the later modification a number of mules were driven abreast about a circular paved or cemented yard, or *patio,* upon the floor of which the crushed ore was spread. Salt and blue vitriol, together with mercury were then added, the mercury being applied after the copper, salt, and the whole trodden for several weeks. This process is still in use in many places in Mexico, though mechanical means are being more employed for mixing, thereby saving no time but considerable expense of treatment and mercury.

The mines of El Oro are located in a town of the same name, in the State of Mexico, on a branch railroad six miles from Tultenango, a station on the National Railroad. It is about 100 miles northwest of Mexico City. The altitude above sea level is 10,000 feet, and the population today is about 15,000, of whom about 500 are English-speaking.

THE END OF THE EL ORO PANORAMA, SHOWING THE PRINCIPAL MINES.

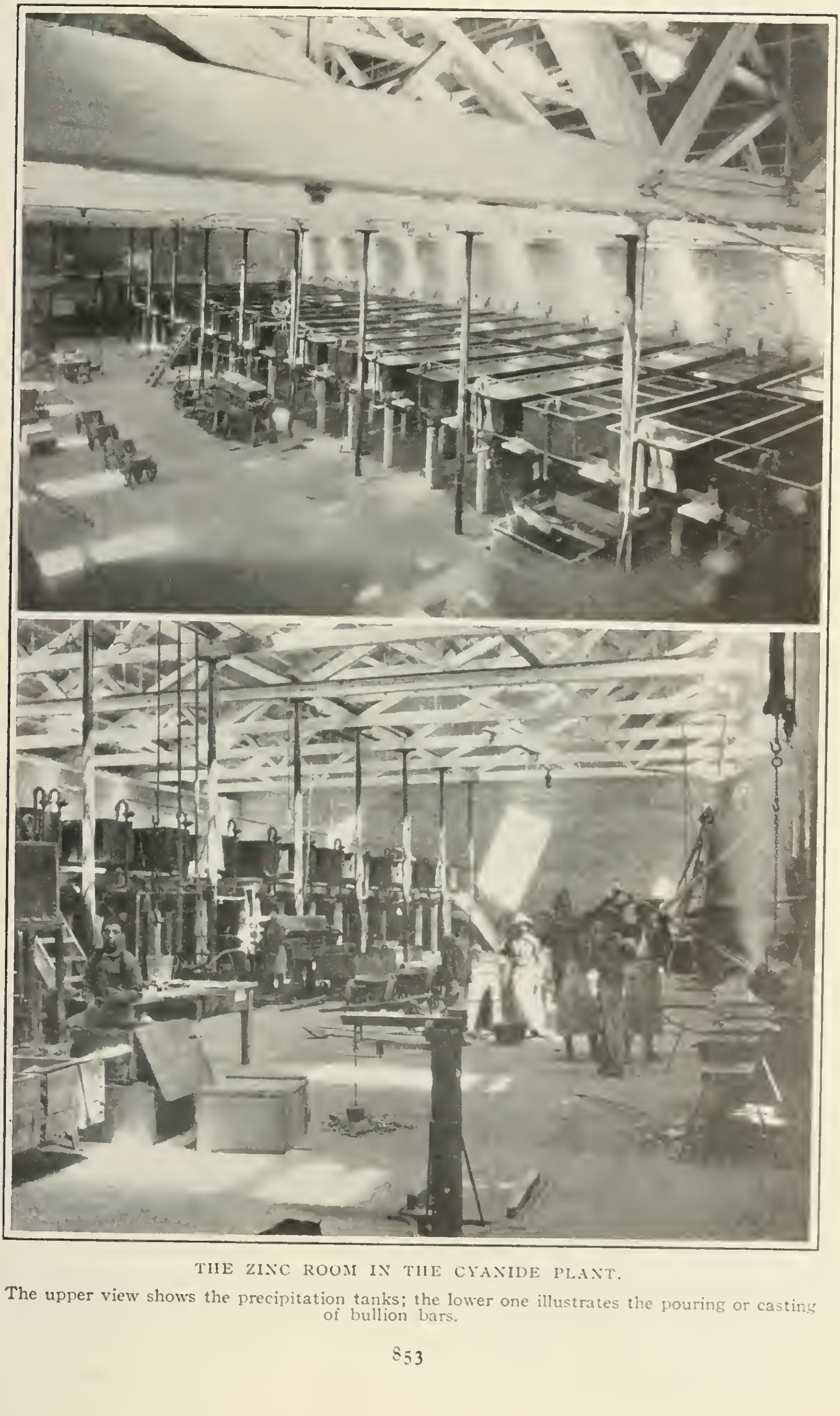
The entire district of El Oro is what is known as a "rich man's camp," on account of the depth of the apex of the vein below the surface and the expense entailed in sinking, timbering, pumping, hoisting, etc. A volcanic capping covers the slate, usually to a depth of 150 to 500 feet. The veins were formed in the slate previous to the volcanic overflow of andesite, or in the breccia, so that they have no outcrop to the surface. The dip of the veins is toward the west, from 60 to 70 degrees with the horizontal. The matrix is a pure silica containing the gold and silver in a finely divided state, invisible to the naked eye. The gold runs from a few dollars to $150.00, and the silver from $8.00 up to $10.00 per ton, United States currency. It varies in richness throughout its length.

The San Rafael vein extends through the Carmen, El Oro, and Esperanza properties, measuring from 20 feet wide on the south to 150 feet wide on the north, all within the El Oro boundaries, which are 5,200 feet long. The wider end of the vein is next to Esperanza, and from the loose nature of the rock, much timbering was necessary. There is cedar timbering known to be over 60 years old in good condition today in some of the shafts.

These mines were first worked by the Indians and Spaniards a hundred years ago, in an extremely crude manner, the ore being treated by amalgamation in *arrastras* or by the *patio* process, principally in the *hacienda* below the town. " Chicken " ladders, made of trees with notches cut for steps, were used in the shafts. These were in use until comparatively recently, and may still be found in some mines in the vicinity. The stories of the enormous weights the natives were able to carry up these ladders are hardly credible. The war of Independence for a time put a stop to the mining at El Oro, and it was not renewed until about 1821. English capital was being attracted to Mexico about this time. The United Mexican Co., with a capital of $6,000,000, took up the work. On account of the remoteness of El Oro and the unsettled condition of the country, frequent robberies and loss of life compelled this company to withdraw in 1857. They sold out the same year to "La Compañía Restauradora," who sank many new shafts, the principal one worked being the Providencia, which was sunk to some 700 feet. At this shaft the United Mexican Co. had installed a cylindrical Cornish pump and hoisting engine in 1828. The former was afterward moved to another mine in the Tlapujahua district, near by, from which it has but just been removed.

A number of Cornish miners were brought over to assist in the work in the mines, in 1847. As indicating the dangers of travel, it is stated that they were robbed four times en route to destination. Bandits frequently attacked the camp. The " Casa Blanca," which was a large building built on four sides of a central square or *patio,* and which at the present time serves as the offices and home of the manager, was at one time attacked by three hundred revolutionary Mexican soldiers in efforts to rob the company's treasury, but was safely held by the manager and sixteen Cornishmen. About 1849 an epidemic of diseases and plagues reduced the population one half.

In 1879 the El Oro mines passed into the hands of General Frisbie and J. B. Haggin, the new owners being organized as the American Mining Co. Ten stamps had been erected in 1873, and these were later increased to twenty-five stamps, with amalgamating pans, augmented by Chilian mills. In 1895 the first cyanide treatment was undertaken. Not enough water is taken from the mine to supply the needs of the milling and cyaniding, so that some has to be purchased from another source. In 1898 a 100-stamp mill was erected to treat 200 tons of ore a day. Several new shafts were also sunk during this period. There was at this time said to be enough ore to run this new mill twenty-five years.



THE ZINC ROOM IN THE CYANIDE PLANT.

The upper view shows the precipitation tanks; the lower one illustrates the pouring or casting of bullion bars.

In 1899 a narrow-gauge railway was built from Tultenango, on the National Railroad, to El Oro, and extended to timber lands 25 miles beyond. A large quantity of this wood is used for timbering the mine, and until very recently as fuel for the boilers. The El Oro Mining & Railway Co., Ltd., purchased the property from Messrs. Frisbie and Haggin in 1900. The workings of the El Oro mine are now down to a depth of 1,200 feet in the Somera shaft.

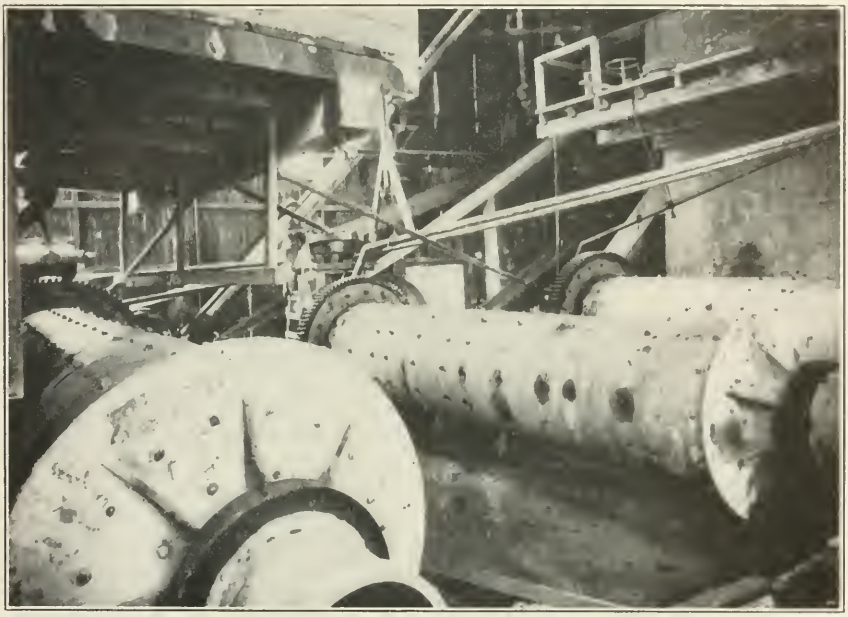
In Mexico, unlike in the United States, the owners' surface property line extends in a vertical plane downward, and beyond this he may not go. Up to 1895 no one believed that the San Rafael vein, upon which the El Oro Company was working, extended beyond this company's boundaries. Mr. August Sahlberg, ignoring this belief regarding the vein ending in the El Oro property, began what is now the Esperanza Mine, northwest of the Oro, and it is today one of the largest gold-producing mines in the world. Seventeen years ago the El Oro was the only claim in the El Oro district proper, while in 1900 there were between twenty and thirty, with but about five producing bullion.

The gold is found in a state of extremely fine division, which renders either pan or plate amalgamation difficult; only about 15 to 20 per cent of the gold value is thus obtainable. The remainder is recovered by cyaniding; the cyanide process therefore has rendered possible the successful treatment of what, without it, would have been worthless. The cyanide attacks the infinitesimal parts of gold and dissolves them, after which the solution passes through zinc shavings on which the gold is precipitated.

Mr. P. L. Foster, general manager, reported in June, 1902, the average gross value of the whole quantity of ore treated for the eleven months preceding had been $17.32 per ton, in gold and silver, of which $13.52 was recovered; the working expenses, including mining, milling, development, taxes, amounted to $5.11 per ton. Mr. Foster resigned the management in 1902 to accept an important position with the Exploration Co., Ltd., of London, of which company the El Oro Mining & Railway Co., Ltd., is an allied interest. Mr. R. M. Raymond has succeeded him as general manager.

The wages now paid in the El Oro camp in Mexican currency per day are approximately as follows: boys 25 cents, *peones* 37½ cents to 50 cents, miners $1.00, timber men $1.50, mechanics $3.00 to $5.00. Wood costs about $8.00 per cord.

An additional 100-stamp mill, costing $1,005,000, was recently completed, being entirely paid for out of profits earned. It was started late in 1905, operating 70 stamps in March, and the entire 100 stamps in May. In it were installed three large tube mills, belt-driven from the main shaft, for grinding the sands from the stamp. By means of these, two-thirds of the ore crushed is reduced to slimes and the remaining sands are reduced to 100- to 200-mesh fine, thereby getting a better extraction of gold and silver. $1,527,723.00 was produced in 1905 from mill and cyanide plants.



TUBE MILLS AT MILL NO. 2, BELT-DRIVEN FROM THE MAIN MILL SHAFT.

In consideration of the large amount of power used in the El Oro camp and vicinity, all being developed by steam, with wood costing from $3.50 to $4.50 per cord and American coal $11.00 per ton, United States currency, the Mexican Light & Power Co. decided to extend their transmission (already operating from Necaxa to Mexico City) 90 miles farther to El Oro, their circuit thus forming an obtuse angle, with Mexico City at the apex. They contracted with the three largest consumers, the El Oro Mining & Railway Co., the Esperanza Co., and Dos Estrellas, for approximately 10,000 horse power.

The source of electric power for the entire El Oro district is 171 miles distant, near Necaxa, in the State of Puebla, where the Mexican Light & Power Co. have their main generating station, one hundred miles northwest of Mexico City. Near Necaxa the Tenango River unites with the Necaxa River, giving a minimum flow in the dry season of 1 cubic metre a second, with a maximum of some 90 cubic metres. The river drops 3,000 feet in about three miles, on its way to the Gulf of Mexico. The first plant, now being installed, will utilize two falls, making a total of 1,300 feet head or about 40,000 electric horse power. A second fall of 1,300 feet is available down stream, for the further development of 40,000 horse power more when needed. The water wheels used are capable of developing 8,200 horse power each, and there will be six 5,000-kilowatt, direct-connected, vertical-shaft, alternating-current generators, revolving-field type, 3-phase, 4,000-volts, 50-cycles, making 300 revolutions. This voltage is raised by transformers to 60,000 volts, and the energy transmitted about 96 miles to Mexico City, over four 3-phase circuits comprising twelve 168,000-circular-mils stranded copper cables, each of which corresponds to about No. 000 B. & S. wire.

THE DISTRIBUTING SUB-STATION AT EL ORO.

These cables are carried on two steel-tower lines, two circuits to a line. A similar single-tower line with two circuits transmits a part of the energy from Mexico City to El Oro, a distance of 75 miles. In El Oro at the sub-station, which is equipped with lightning arresters, transformers, and switchboard, the voltage is reduced to 3,000 volts before distributing to the various mining and milling customers, the most distant of which is about six miles. There are seven 1800-kilowatt transformers installed in this sub-station.

The El Oro Mining & Railway Co., during the latter part of 1905, purchased of the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., its entire electrical equipment of motors, generators, transformers, switchboards, etc., amounting to some 4,000 horse power of machines. This has been installed, and the mine, mill, and cyanide plant have been operating in part electrically since early in January, 1906. This, too, at a time when the expense of developing power from wood was increasing owing to the longer hauls and difficulty of lumbering. Inasmuch as the Esperanza Company is also entirely equipped electrically, no smoke is now to be seen issuing from the once very busy stacks in El Oro. The methods adopted by the El Oro Company, which is today undoubtedly the largest electrically operated mill in the world, in changing from steam to electric drive without the necessity of abandoning the original machines employed in the mine, mill, or cyanide plant, may be of interest.

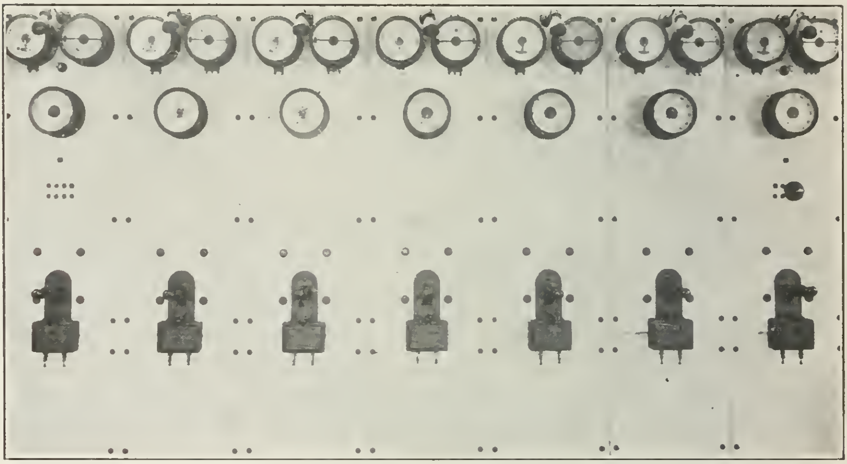
It might be said here that the one tool in use which seemed to defy motor application was the steam trip-hammer in the blacksmith shop. This finally succumbed, however, and is operated by compressed air supplied from an electrically driven compressor.

All the motors employed are 3-phase, 50-cycle (6,000 alternations) and as a rule are 400-volt, induction type for 200-horse-power and less, and 3,000-volt synchronous above 200 horse power.

A separate sub-station has been provided by the El Oro Co. to receive the current from the power company and distribute it to the various mills and mine shafts. Here the power is measured by the power company with integrating wattmeters and passed to the seven-panel Vermont-marble distributing switchboard, each panel of which contains the usual instruments and switches. Since the photograph was taken from which the cut on page 858 was made, integrating wattmeters have been added to the base panels so that each department can be charged up regularly with the power used.

Most of the ore is hoisted at the incline shaft and dumped automatically into hoppers feeding two large gyratory crushers, belt-driven by a 100-horse-power motor. Other individually motor-driven jaw crushers are also used to assist in handling the large amount of ore.

The duty capable of being performed by this hoist, unbalanced, is as follows: weight of ore, 6,000 pounds; weight of skip, 4,000 pounds; weight of rope, 2,000 pounds; hoisting speed, 900 feet per minute. This is to be operated from a direct-current motor, direct-coupled to the pinion shaft of the hoist, the motor receiving its current from an alternating-current motor-generator set with a very heavy flywheel mounted on its shaft, all of which will be described* in connection with the Somera Shaft where the same novel economical system is employed. The only change necessary in the steam hoist to adapt it to electric drive was the replacing of the pinion shaft with a similar one slightly longer to receive a half coupling from the motor. This same method was employed with all the other hoists. In this way steam drive can be renewed at any time should it become necessary through lack of power. The changing of the shafts would require but about half an hour, or less time than necessary to steam up.



SEVEN-PANEL DISTRIBUTING SWITCHBOARD IN THE COMPANY'S SUB-STATION.

The ore from the crushers is run into cars and distributed in the ore bins above the stamps of Mill No. 1, which is very close, or run onto a belt conveyor and elevated slightly to the ore bins of Mill No. 2. In this it passes over three motor-driven belt conveyors and is distributed automatically at its destination. These conveyors require motors of 10 and 15 horse power capacity each. Ore is also supplied to Mill No. 2 from San Rafael shaft where it is electrically hoisted and crushed as at the incline. A belt conveyor connects this shaft and Mill No. 2. By this series of conveyors the ore can be automatically sent to whichever mill may be desired.

In Mill No. 1, the older mill, the main stamp shaft was formerly rope-driven from its engine; a 350-horse-power synchronous motor making 187 revolutions now rope-drives the same shaft. From this main shaft a belt drive transmits the power to the cam shafts of the batteries in groups of ten stamps. The cam shaft makes close to 50

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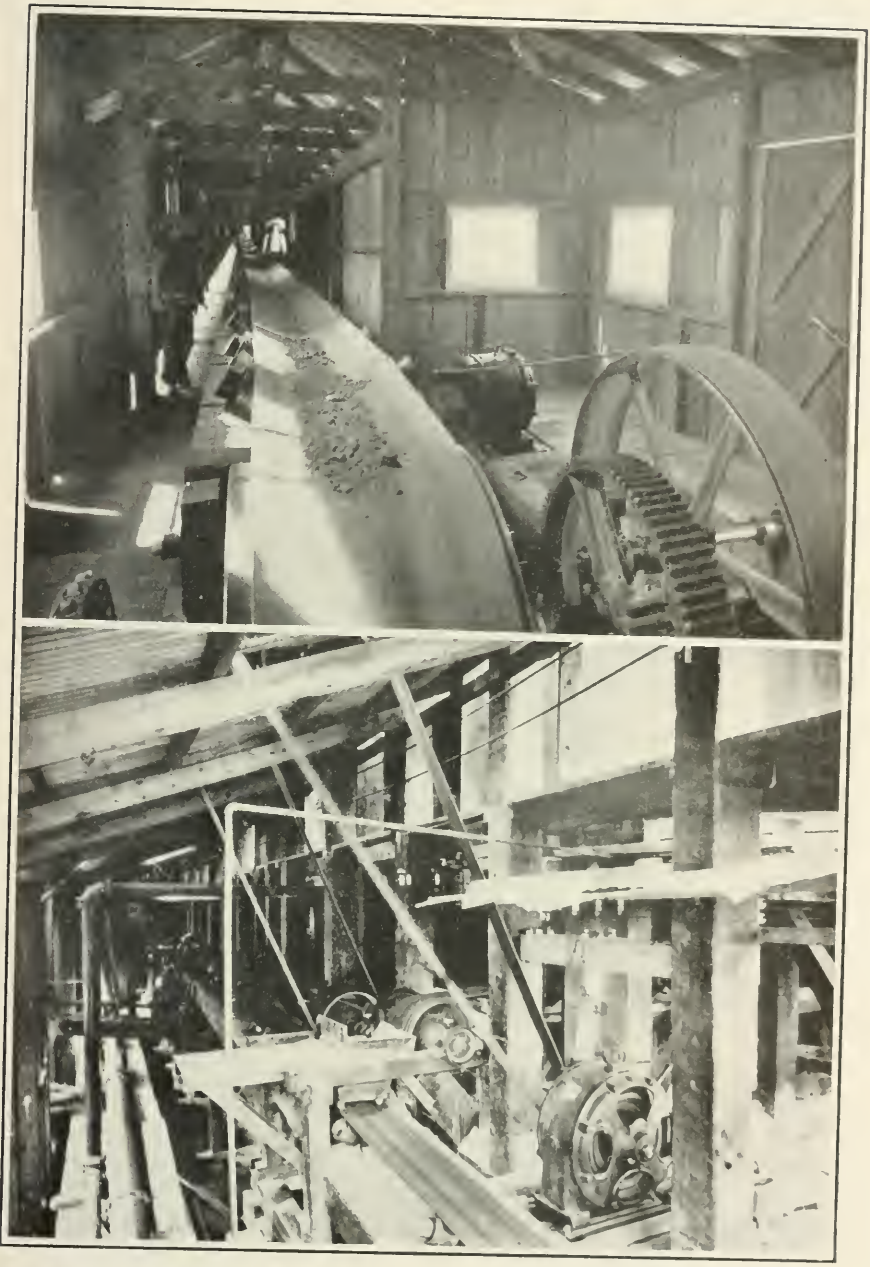
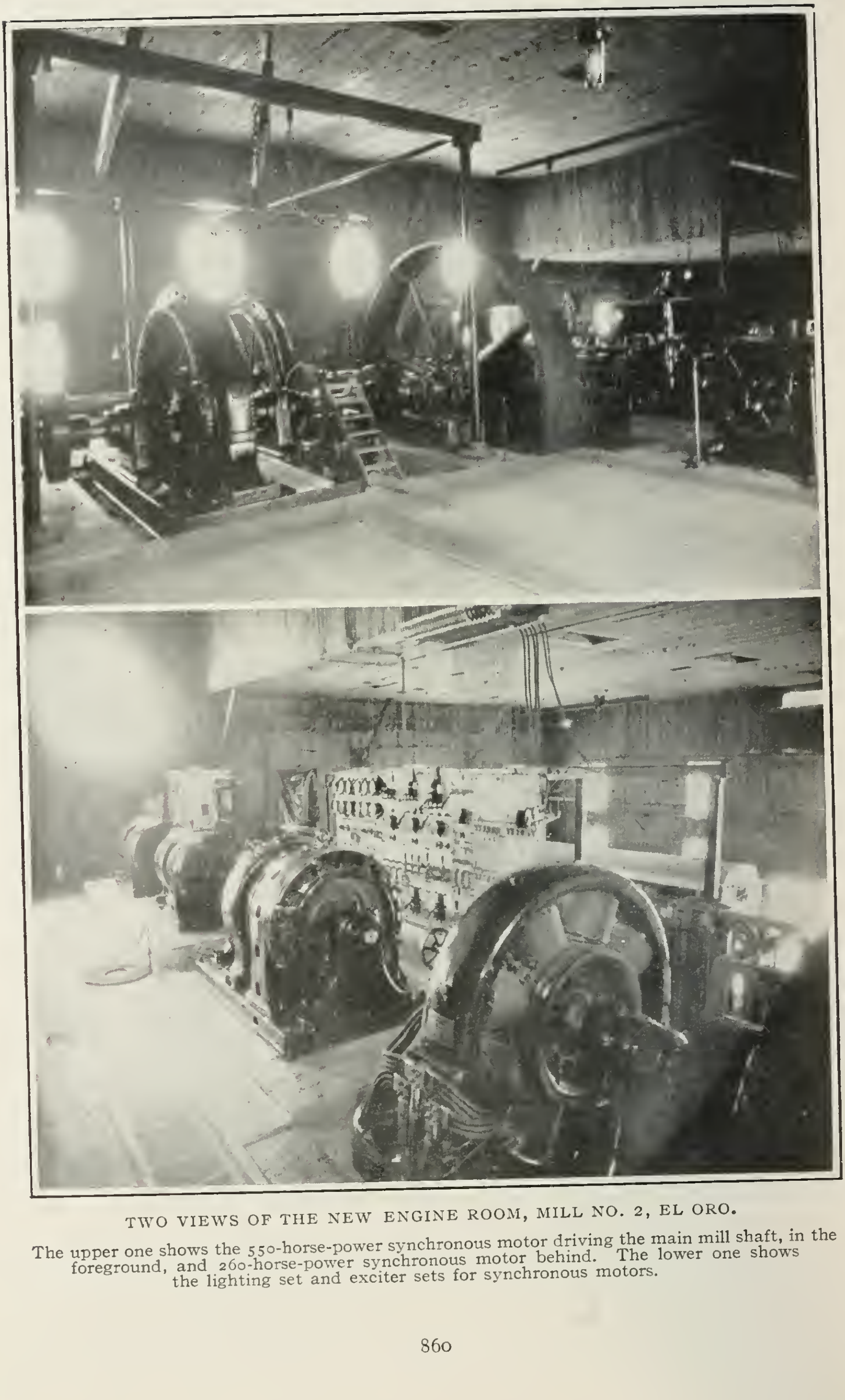
*This will appear in the conclusion of Mr. Allen's article, in our October issue.—Ed.



SOME OF THE ELECTRICALLY DRIVEN CONVEYORS.

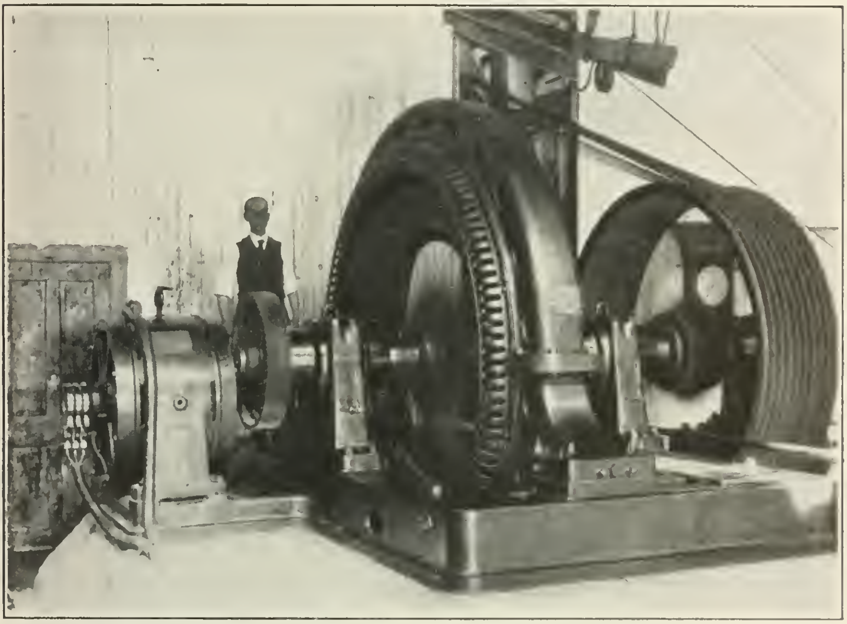
The upper view is of the ore belt conveyor from the crushers at the Incline shaft; the lower shows the sand belt conveyor.



TWO VIEWS OF THE NEW ENGINE ROOM, MILL NO. 2, EL ORO.

The upper one shows the 550-horse-power synchronous motor driving the main mill shaft, in the foreground, and 260-horse-power synchronous motor behind. The lower one shows the lighting set and exciter sets for synchronous motors.

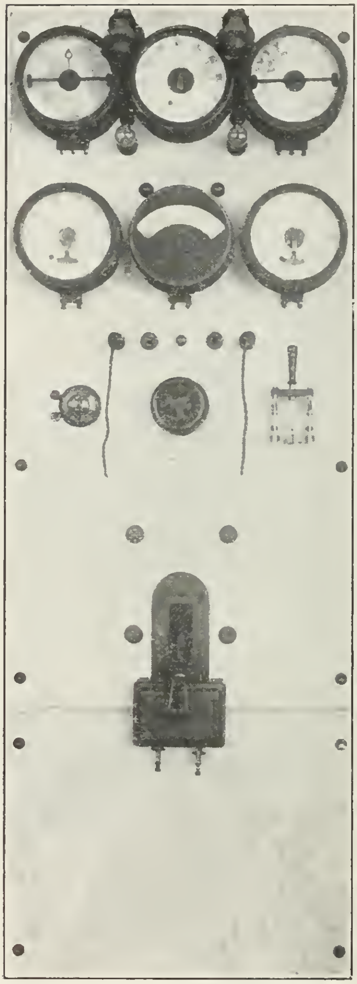
revolutions per minute to give about 100 drops to the stamps a minute, the cams raising the stamps being arranged in pairs, each being diametrically opposite in their position on the shaft. The stamps weigh 1,000 pounds each and are thus lifted 6 inches and dropped by the cams twice each revolution. The duty per stamp is 4.7 tons of ore every 24 hours.



SYNCHRONOUS MOTOR OF 350 HORSE POWER DRIVING THE MAIN MILL SHAFT, MILL NO. 1, EL ORO MINING AND RAILWAY CO.

This 350-horse-power motor, and indeed all the other synchronous motors, is started by means of a small variable-speed induction motor by single gear reduction, the pinion on the starting-motor shaft being on a feather key. Thus the motor can be cut out of service by a hand lever after the large motor is up to synchronism and connected electrically to its circuit. By this separate starting method no synchronizing power (power to keep in step) is lost in the motor, as would be the case were it built for self-starting.

Drum-type controllers and resistances are used to operate all the starting motors and blue Vermont-marble panels control the synchronous motors, these latter being supplied with synchroscopes, indicating wattmeters, power factor meters, ammeters for field and main-line currents, voltmeters, field rheostats, field discharge switches, and main-line automatic oil circuit breakers. Plug jacks are provided on the back of the switchboard for readily plugging in temporarily a portable indicating wattmeter when desired.



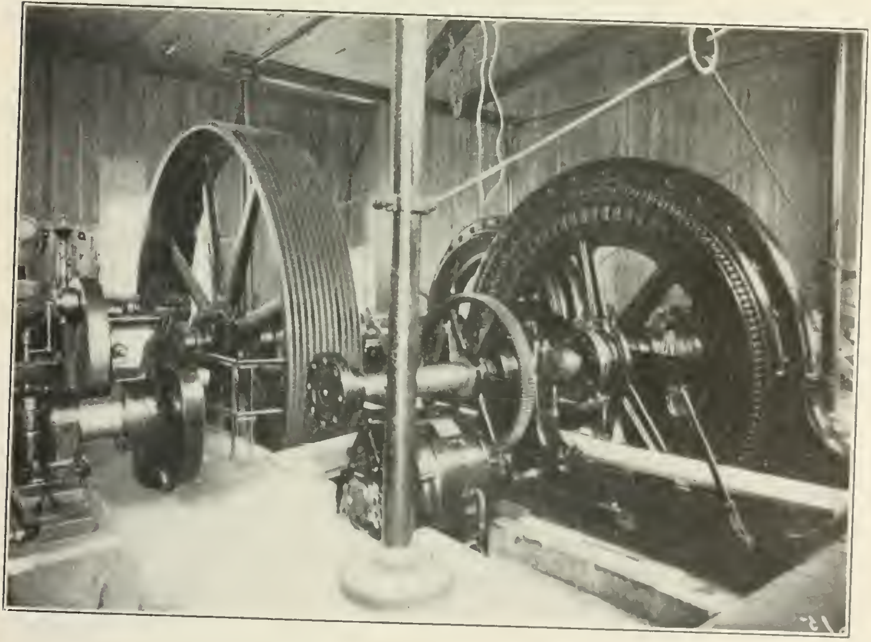
ONE OF THE SYNCHRONOUS-MOTOR PANELS.

As the new mill had been originally ordered with provision for steam drive, before the possibility of electricity coming into the camp was known, it was thought best after contracting for the electric power to keep the engines as far as possible so that they could be placed in service quickly should there be any failure in the power service due to lightning or line disturbances. For this reason the 550-horse-power, 88-revolutions, two-bearing synchronous motor driving the entire 100 stamps and three tube mills, and the 260-horse-power, 88-revolutions, two-bearing synchronous motor driving the cyanide plant, were installed in a very ingenious manner. The motors were constructed with shafts extended on both ends to receive half couplings, the motors being installed between engines and shafts to be driven, with all shafts in each set in line. A flexible coupling of rubber cylinder type connects motor and driven shaft, and a special semi-flexible form of key-plate coupling connects motor and engine shaft. Normally, the bolts and the middle or key section of the latter couplings are left out when the motors are driving. In fifteen minutes or less these can be put in place, thus allowing the engines to drive the shafts, revolving the rotors of the motors at the same time. It has never yet been found necessary to resort to this expedient. On account of their very slow speed these motors are quite large for their capacity

The power service has been remarkably steady, considering the newness of the installation and the distance of El Oro from the source of power, and the power company are certainly sparing no expense to make the service absolutely continuous. The present manager of the power company, Mr. R. F. Hayward, who was formerly connected with various companies in Salt Lake City and vicinity, will certainly bring this about if it is possible.

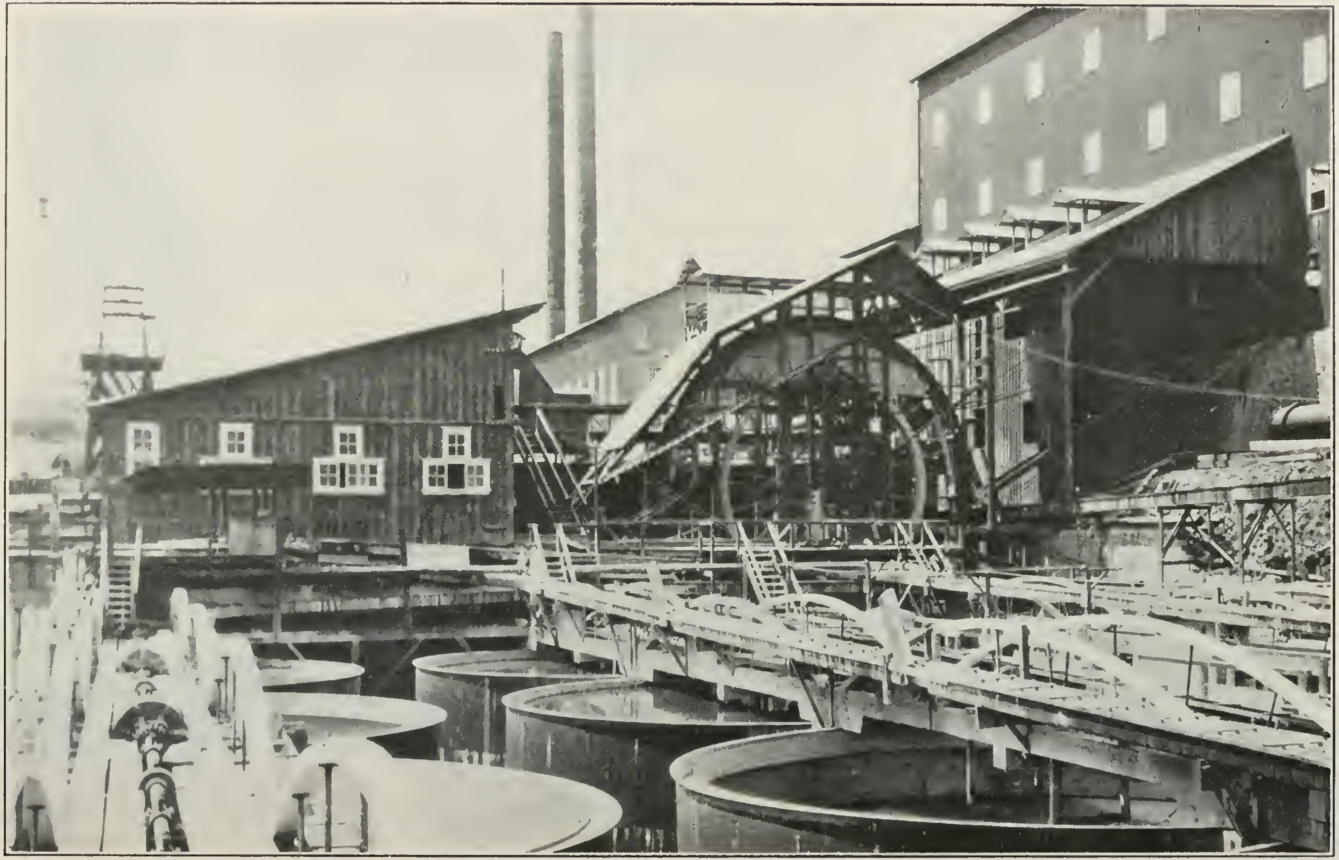
Ordinarily a stamp mill runs 24 hours a day, 365 days a year; nevertheless a brief shut-down may occur due to interruption in power or other cause while running. Any ten stamps in the mill, however, can be shut down at any time without interfering with the rest of the mill, by slacking up the idler pulley on the belt between main and cam shaft. In starting, the main motor is brought up to synchronism by its starting motor, which need be only of sufficient capacity to move the main-motor rotor and the main shaft, all the idlers having been slacked away. After full speed is obtained and the synchronous motor connected to the main circuit, the starting-motor pinion is slipped and the idlers tightened rapidly, so that the starting requires but a few moments. It was at first thought necessary to "hang up" the stamps, but the above method has been found much quicker and equally satisfactory.

A stamp mill cannot be rivaled for noise; but the contrast in the engine room, which is partitioned off from the mill proper, is very apparent, as these large, smooth-running motors make much less noise



PART OF THE NEW ENGINE ROOM, MILL NO. 2.

Showing in the foreground the 260-horse-power motor driving the cyanide plant, and behind it the 550-horse-power motor driving the entire stamp and tube-mill equipment.



A SECTION OF THE CYANIDE PLANT.

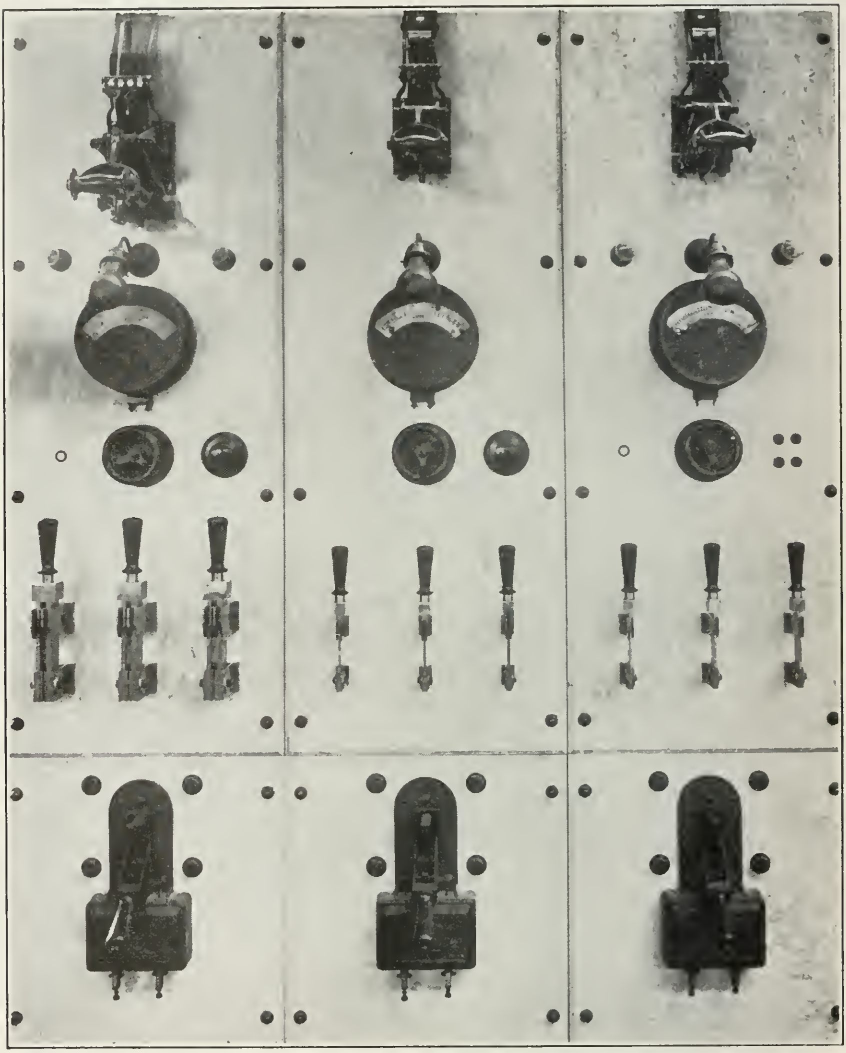
The mechanical agitator shafts, one of which is shown on the left, and the tailings wheel in the background, are driven by individual motors.

than the former engines, not to mention the great saving in oil, repairs, and attendance.

The auxiliary drives in the cyanide plant, which were operated from the shaft now driven by the 260-horse power motor, were originally made by means of long wire-rope drives, some through intermediate counter-shafts carrying the power a considerable distance. Later, individual-motor drives on the cyanide machinery have been installed in several places, avoiding long transmissions and cheapening operation. It is true, this obviates the possibility of driving the cyanide plant from the 260-horse-power engine. To offset this the 260-horse-power synchronous motor which is connected to the engine will be driven as a generator, should it ever be necessary, feeding back through its own panel to the main distributing switchboard, whence the current can be distributed to the motors in whatever part of the mill or mine is without steam.

REAR VIEW OF SWITCHBOARD, NEW ENGINE ROOM OF MILL NO. 2.

In the new engine room are also to be found a 150-kilowatt direct-current, 125-volt lighting generator coupled to an Ideal engine, a part of the original steam equipment. As new apparatus, there is a 150-kilowatt 580-revolution direct-current, compound-wound, 125-volt lighting motor-generator set, for lighting the entire plant and town of



PANELS FOR CONTROLLING MOTOR-GENERATOR LIGHTING AND EXCITER SETS, MILL NO. 2.

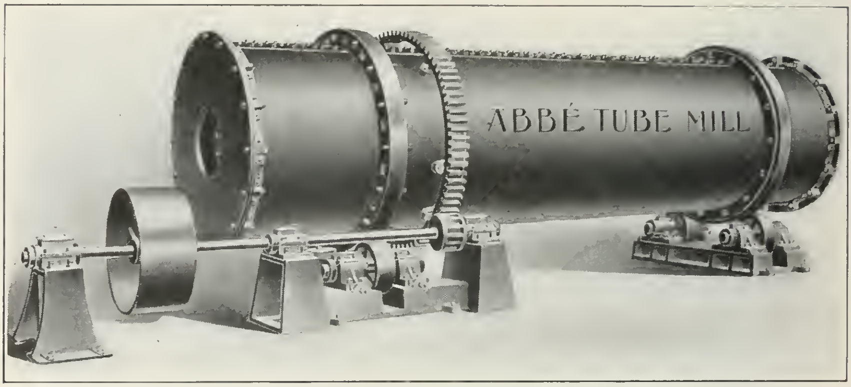
El Oro, driven by a 200-horse-power alternating-current motor, duplicating the above, and two 50-kilowatt 720-revolution direct-current, compound wound, 125- volt motor-generator sets driven by 75-horse-power alternating-current motors, each of which latter has a capacity of exciting the fields of all of the synchronous motors about the plant. These motor-generator sets are self-contained, each with a common base and shaft supported by two bearings. The switchboard for controlling all of the machines in this engine room is built of blue Vermont marble and comprises eight panels with all the necessary instruments.

The auto-starter employed to start the 200-horse-power motor and the other large induction motors about the plant, is of the multi-point, oil-immersed drum type, and being a recent and novel development by the Westinghouse Co., is worth a brief description. This type of starting device is used with constant-speed induction motors, 75-horse-power and over. It is bolted to the floor over a 16-inch hole cut in the same. The oil tank is bolted to the controller frame with two side bolts and is raised and lowered by means of a central threaded screw rod. The same handle that operates the controller, raises and lowers the oil tank by changing a nut at the top of the handle. The tank can be lowered below the floor two feet, which exposes all connections and contacts for inspection and repair. In operation the motion of the handle is always to the right, whether starting or passing from running to off. From six to nine different voltages are applied to the motor from off to full on position, depending on the horse-power capacity of the motor operated, thereby keeping down the peak which would otherwise result from the throw of an ordinary double-throw starting switch.

The ore from the stamps must be reduced to a sand fine enough to pass a 25 to 35 mesh screen, after which it passes over amalgamating plates which recover 15 to 20 per cent of the gold and 1 to 5 per cent of the silver. The amalgam from the plates when retorted into bullion contains about equal parts by weight of silver and gold.

The pulp from the plates was formerly passed direct to the cyanide tanks for treatment, in which latter process only about 80 per cent of the gold was dissolved, the loss being due to the sand grain still containing some gold secreted which the cyanide solution could not attack. Classifiers between stamp plates and the tube mills now separate the slimes and finest sands from the coarser sands, which latter pass through the tube mills. The three large tube mills receive the classified sands from Mill No. 2 for regrinding, and two additional tube mills, each belt-driven by a 50-horse-power motor, are being installed to handle the sands of Mill No. 1. Of the three tube mills, the smaller one has given the most satisfaction and least trouble, for which reason smaller mills were adopted for the second installation. The capacity of the smaller mills is but very little less, the expense of running is much lower, they are light, compact, and need little repair.

In setting a tube mill, special care is necessary with the foundations on account of the constant hammering of the revolving pebbles and



A TUBE MILL OF THE EL ORO INSTALLATION.
Abbé Engineering Co., New York.

vibrations of the spur gears, which tend to crystallize and break the anchor bolts and drive the mill into the cement. Tube mills for regrinding have proven most successful in El Oro, and it has been found by tests that a tube-mill efficiency increases directly proportionally to the amount of pebbles contained therein up to a certain point. The "Danish" pebbles used cost \$36.80 per ton at the mill, the average pebble consumption being five pounds to the ton of sand. The lining of these pebble mills, which is subject to comparatively rapid wear, is composed of cast-iron strips, cast to fit the inside curved surface; these are made in the El Oro Company's foundry, having been found to last as long as the ones formerly imported from Germany, and to cost but half as much. The consumption of lining is roughly 1.2 pounds per ton of sand. Some preliminary comparative tests of the cost of grinding and regrinding by tube mills showed, per ton of sand passed through the mills, \$0.367 using steam, and \$0.274 using electric power. The cost of grinding fine sand was found to be far greater than for coarse sand, on account of the greater wear of pebbles and liners in the former case.*

In the treatment of the slimes a number of small motors, 50-horsepower and under, are employed at a great saving over the former method by steam drive, due not only to the reduced cost of power per horse power, but to the ability to shut down motors on machines not requiring continuous operation in the process. In this work many machines are in operation only at intervals, some of the motors being idle while the tanks are being refilled, emptied, or the solution changed from one to the other. The motors here are in all cases constant speed, except on the mechanical excavators and sand distributors, where they are variable-speed. The constant-speed motor applications are in part the tailings wheel, mechanical agitators, solution, slime, and circulating pumps, sand conveyors, stackers, etc.

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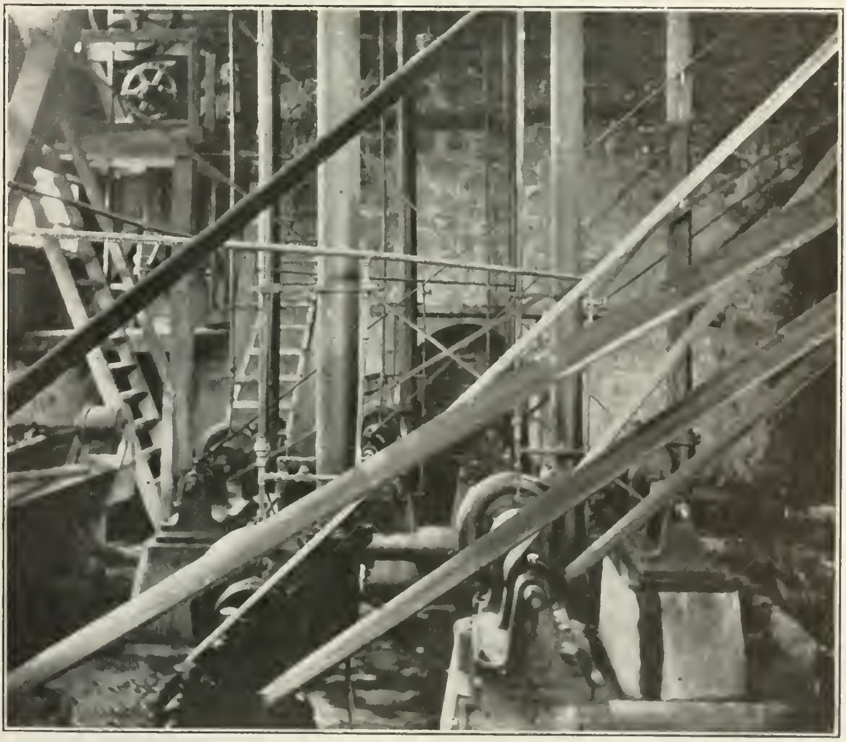
*A very thorough paper by Mr. G Caetarni and Mr. E. Burt, the latter having charge of the cyanide department for the El Oro Company, entitled "Fine Grinding of Ore by Tube Mills, and Cyaniding at El Oro", read before the American Institute of Mining Engineers, February, 1906, will prove interesting as bearing on this subject.

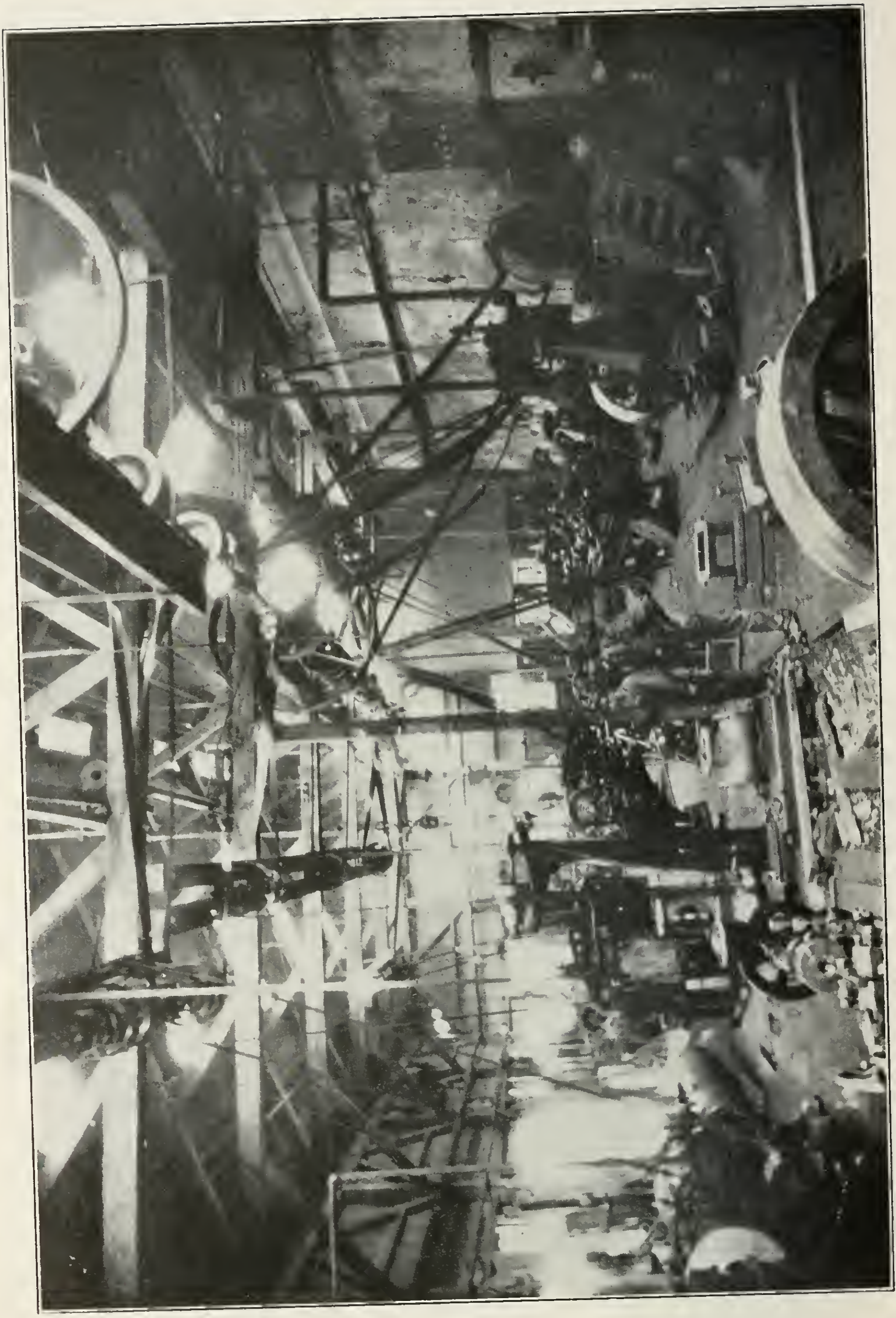
There are two solution pumps for handling the cyanide solutions of different strengths, the cyanide being recovered and used over, and seven Butters pumps for the circulation of the slimes. The mechanical agitators are driven in groups of three to a motor. These agitators merely consist of wooden arms which stir the slime and cyanide solution together.

The mechanical excavators consist of a series of discs, similar to a disc plow, attached to radial arms supported above by a platform running on rails over the tanks. These rotate by means of a motor geared to the vertical shaft, plowing the sand toward a hole in the

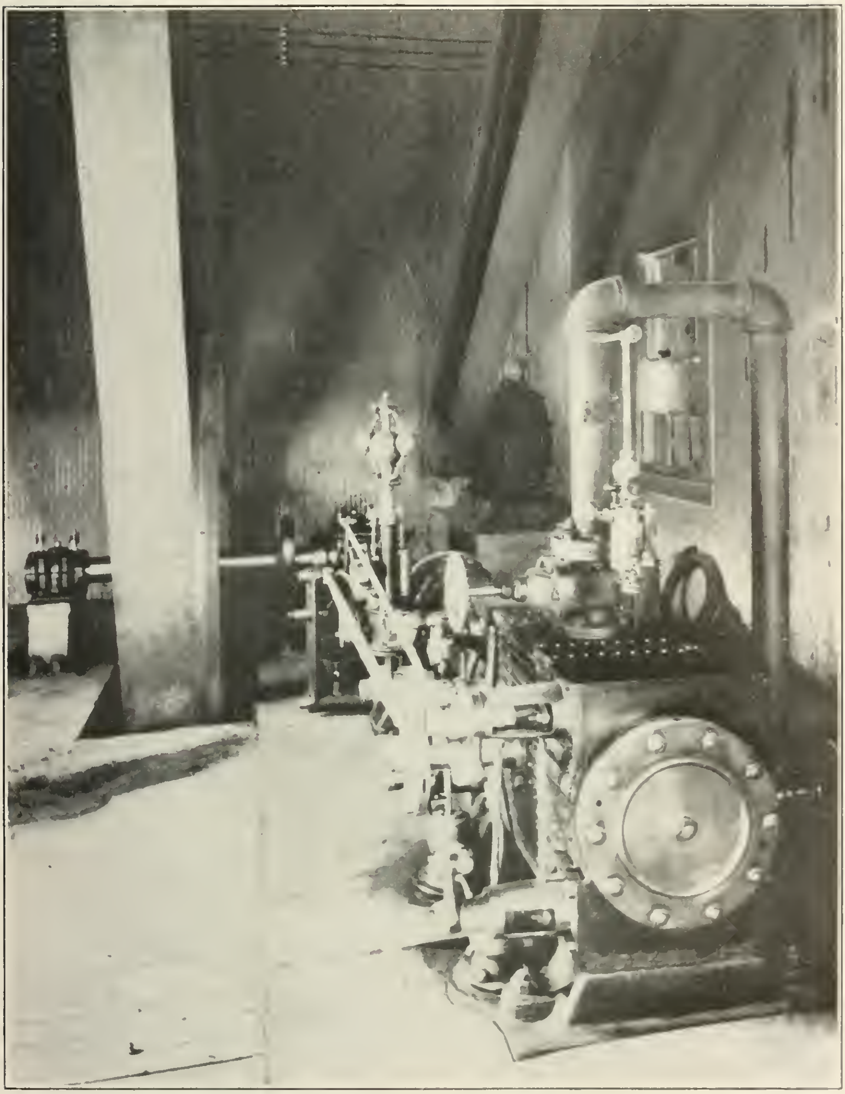


SEVEN SLIME-CIRCULATING PUMPS IN THE CYANIDE PLANT, ELECTRICALLY DRIVEN.

The driving motor may be seen in the upper left corner.



MACHINE SHOP DRIVEN BY 40-HORSE-POWER MOTOR.



FRAMING-SHOP MOTOR, 40-HORSE-POWER; SHOWING THE ABANDONED ENGINE FORMERLY USED FOR THE DRIVE.

center of the tank where it falls onto a belt conveyor and is carried to other tanks, to be distributed therein and treated by cyanide again, or passes to the stacker where it is dumped on the tailings pile if its treatment is complete.

These excavators, as well as the sand distributors which are also constructed with platforms supporting the machinery over the tanks, and mounted on rails, can be rolled over any tank desired, the current for the motors being taken from trolley wires at the side by sliding shoes.

The approximate cost of slime treatment by steam drive was $0.90 per ton as against $0.50 at present by use of electricity.

Several large electric centrifugal pumps for handling water are in use, requiring motors up to 130-horse-power capacity. One 130-horse-power motor drives a Gould's station mine pump in the incline shaft, handling 500 gallons of water per minute against a head of 800 feet.

The machine and framing shop each take a 40-horse-power motor, and other motors are located in the assay office, blacksmith shop, etc. A 150-horse-power synchronous motor by belting drives a 12-drill air compressor and a 200-horse-power 166-revolution direct-connected synchronous-motor air compressor is contemplated shortly. Two of these latter outfits are now in operation at the Dos Estrellas mines nearby.

At the North shaft, which is used principally for raising and lowering men and timber, there is installed a 120-horse-power variable-speed induction motor coupled direct to the pinion shaft of the hoist, the speed at full load being 194 revolutions. Although in addition to the motor the original mechancial brake is used, for further safety an ingenious device is used in employing the old steam cylinders of the hoist. In lowering a cage down the shaft the pistons are made to compress air in the cylinders, so that by opening or closing a valve connected thereto very fine speed regulation can be obtained. Some hoist builders today in building large new electric hoists apply a small compressor for like braking purposes.

A concluding article next month will complete the description of the installation at El Oro, and especially the hoisting outfit at the Somera shaft, which embodies some very interesting advances in practice as affecting the economy of electric hoisting machinery.

SYSTEMS FOR SIMPLIFYING SHOP SUPERVISION.

By *Albert W. Thompson.*

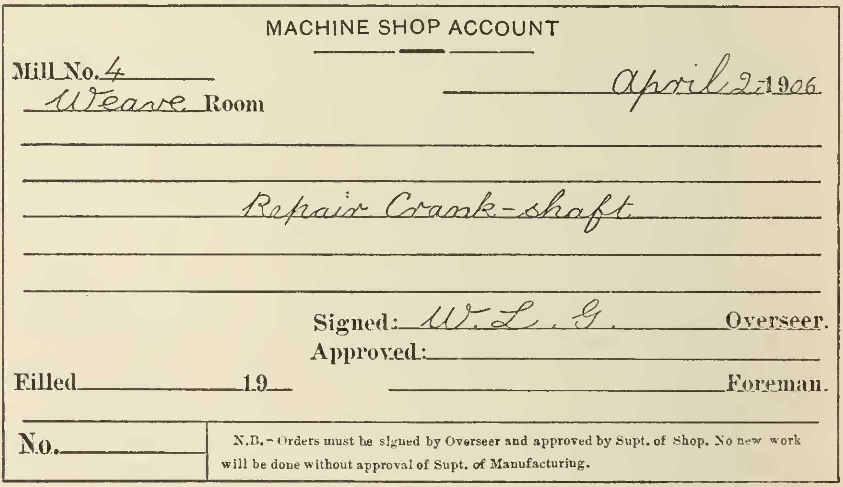
Dr. Louis Bell, earlier in this issue, suggests that there are dangers lurking in over-confidence in system and specialization. He is considering solely the physical product of the plant. But there are not lacking those who protest also against the over-indulgence in "systems" in the administrative work of the shop or factory—who have been surfeited with forms and cards and records until they find the burdens almost greater than the benefits. For the sake of such as these Mr. Thompson describes the sane, simple methods, almost self-operating, and the few forms, which he has found adequate in the conduct of the shops under his charge. It is a plan which has the record of success behind it.—THE EDITORS.

IN many small machine shops, whether engaged in manufacturing, repairs, or jobbing, the work is of such a nature that the manager, or superintendent, if he be a man possessed of an ordinarily good memory, is able to conduct the affairs of the shop without the aid of any other clerical assistance than that of his pay-roll clerk or book-keeper. As the business grows, the manager, growing with it in knowledge of detail, may still conduct it successfully without the aid of systems of reports or statistics, for he "carries them in his head." When he retires, however, his successor is confronted with a task of no mean proportions. His predecessor was the organization and the organization has departed with him; a new organization must be quickly supplied, and system is the only resource which the new manager can depend upon. The problem is often presented in this form, but under widely varying conditions, and the system must be designed to meet the requirements of each particular case.

In a large shop a good clerical force does not add a relatively large amount to the general expense, and a well organized department for estimating time on premium work is unquestionably a necessity, yet in a small shop such a department would be an extravagance. On the other hand, it would be absurd for the small shop to forego the advantages of premium work simply because it cannot afford an expert estimating department, and in this, as in nearly every case, the small shop must have a system designed to fit its own requirements. Generally speaking, the smaller the shop the greater the relative cost of clerical work; there are, nevertheless, many ways by which the burdens of the supervising officers may be greatly lessened, and it is the purpose of this article to describe certain methods of this kind as applied in the machine shop of the Amoskeag Manufacturing Company.

The Amoskeag Company is engaged in textile manufacturing, operating 18,000 looms and employing 12,000 operatives, and the principal business of the machine shop is repairs for this large plant, and the manufacture of some lines of textile machinery for local use. For descriptive purposes the work may be classified as follows:

1.—Repairs by shop work, such as patching, re-fitting, etc., covering a large class of work which must be done in the shop.
2.—Repairs by spare parts, which can be replaced in the mills, the spare parts being furnished by the shop.
3.—Alterations, such as attaching warp-stop motions to looms, the parts for which are made in the shop and then put on in the mills by shop employees.
4.—Manufacturing, including the building of new machinery, and such apparatus as trucks, filling boxes, etc.



MACHINE SHOP ACCOUNT

Mill No. 4
Weave Room
april 2 1906

Repair Crank-shaft

Signed: W. L. G. Overseer.
Approved:
Filled 19 Foreman.

No.
N.B.—Orders must be signed by Overseer and approved by Supt. of Shop. No new work will be done without approval of Supt. of Manufacturing.

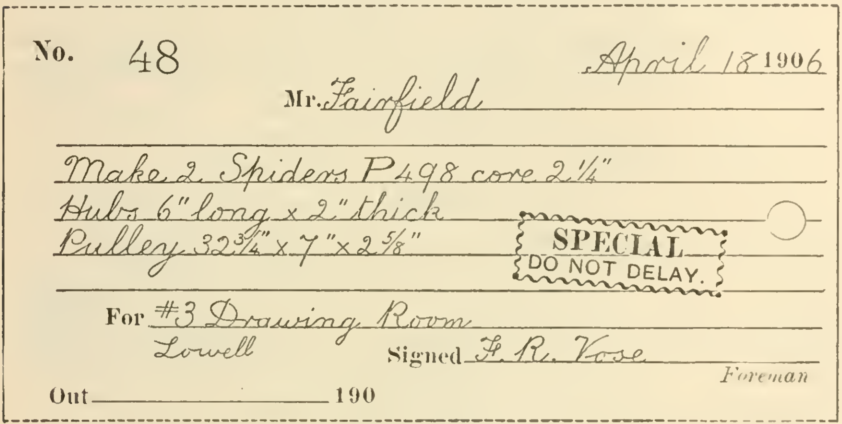
The Engineering Magazine

FIG. 1. OVERSEER'S ORDER FOR REPAIRS.

White-paper, 8 by 5½.

The first class of work is of great variety, and offers no field for premium work, but being generally of a simple nature calls for foremen's supervision only, except that the more urgent cases require the attention of the superintendent to ensure prompt completion of work. The last three classes, however, involve the manufacture of duplicate parts in large quantities, affording a good field for the premium system and also demanding supervision to ensure proper routing of the work through the several departments, and rapid completion in order of importance.

The foundry employs about 60 hands under one foreman, and the machine shop about 250 hands in six different departments, each under a foreman. To simplify supervision, therefore, and to aid foremen in giving proper precedence to different classes of work, some system plainly is required. To this end all work is done upon written orders, and each order is designated as "Rush," "Special," or "Routine," in order of importance. All orders are originally issued from the shop office, or are sent through the office from other departments for approval; supplementary orders for details are issued by foremen as required.



No. 48 April 18 1906

Mr. Fairfield

Make 2 Spiders P498 core 2¼"
Hubs 6" long x 2" thick
Pulley 32¾" x 7" x 2⅝"

SPECIAL
DO NOT DELAY.

For #3 Drawing Room
Lowell

Signed F. R. Vose
Foreman

Out __________ 190

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FIG. 2. ORDER FOR REPAIRS, AS FILLED OUT IN SHOP OFFICE.

Thin yellow paper, 3 by 6 inches, in triplicate, perforated as shown for folding and tearing apart

The form shown in Figure 1, is used by overseers in the mills in ordering repairs. Such orders are sent from the shop office to the proper foreman, if for routine work, or are held for the approval of the superintendent, if of an unusual nature. The form most used is shown in Figure 2, and is made up in triplicate by use of carbon copies. In using this form, one copy goes to the foundry or forge shop, one to the foreman who is to finish the work, the third being filed for reference by the person who writes it, if the work is routine. If for special work, each copy is stamped "Special," (See Figure 3) and the third copy is sent to the superintendent. Each foreman has a "special" stamp which he uses at his discretion, but generally, only under orders from the superintendent. The "Rush" stamp is kept in the office, and is used only with the superintendent's approval, the third order copy going to the superintendent. These triplicate copies are kept in a special booklet, indexed for each department, so that the superintendent is thus provided with a constant memorandum of all important work in process in every department.

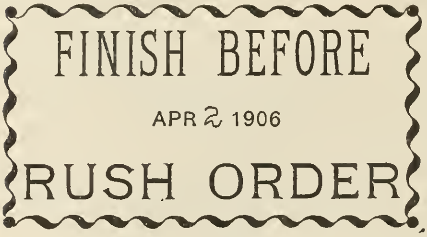
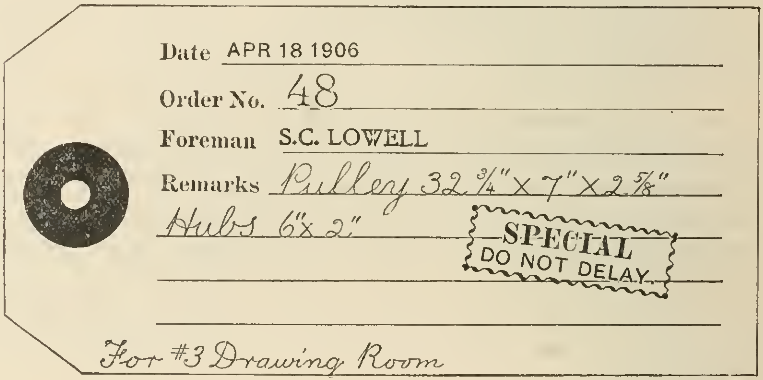

FINISH BEFORE
APR 2 1906
RUSH ORDER

FIG. 3. STAMP FOR SPECIAL WORK. USED IN CONNECTION WITH FORM 2.

To further facilitate the course of important work, a tag is filled out and stamped to correspond with all "Rush" and "Special" orders, and is sent to the foundry with the order. When the casting is made it is sent to the shop with the tag attached, and as soon as received at the shop it is promptly delivered to the department indicated by the tag. In the case illustrated (See Figure 4) the tag furnishes the specifications for a wood-rimmed pulley. The order, bearing the same number as the tag, informs the foreman how many spiders of this size are to be finished, while the tags enable the operative to identify the spiders and give him the sizes to which they are to be bored, the same of course applying to the work of finishing the rims in the wood room. Little remains to be done in the way of supervision except for the superintendent to see that the work is commenced and completed to meet his requirements, which, with the order copies on file in his hand book, is a simple task, leaving little or nothing to the memory of any individual.

This system has given very good results, and the troubles which used frequently to arise from "side-tracking" prior to its introduction have now practically become unknown.

The manufacture of spare parts is conducted under the operation of a separate system which requires very little official supervision.

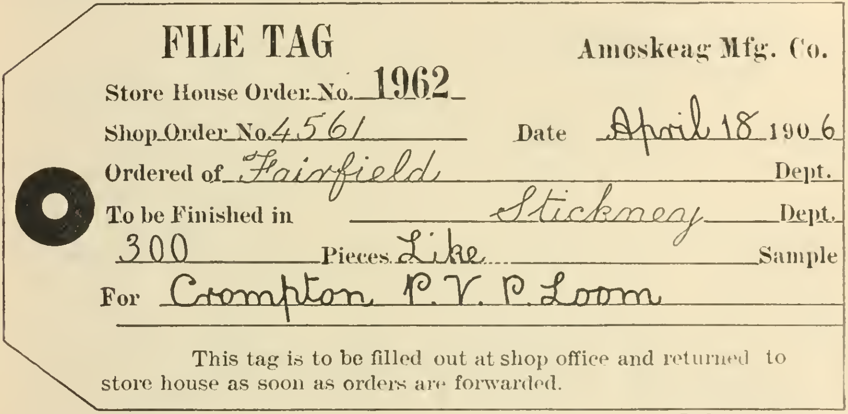

Date APR 18 1906
Order No. 48
Foreman S.C. LOWELL
Remarks Pulley 32 ¾" x 7" x 2 ⅝"
Hubs 6" x 2"
SPECIAL
DO NOT DELAY
For #3 Drawing Room

The Engineering Magazine

FIG. 4. TAG FOR RUSH WORK AND SPECIAL ORDERS.

The tag is distinguished by a bright blue color. It is shown with "rush" stamp affixed.

All finished spare parts are kept in stock in the stores department which has no connection with the machine shop. The stores keeper orders spare parts, according to his own requirements, usually several weeks ahead of the time when he expects a given supply to be exhausted, and "Store-House Orders" are therefore rarely urgent. Formerly, however, at times when urgent work was plentiful in the shop, the store-house orders were apt to be too long delayed, and would accumulate in the shop to an extent which caused much trouble and annoyance in all deparments. In order to obviate these troubles and to provide means for tracing individual orders, the following system has been adopted with very pleasing results.



FILE TAG **Amoskeag Mfg. Co.**

Store House Order No. 1962

Shop Order No. 4561 Date April 18 1906

Ordered of Fairfield Dept.

To be Finished in Stickney Dept.

300 Pieces Like Sample

For Crompton P. V. P. Loom

This tag is to be filled out at shop office and returned to store house as soon as orders are forwarded.

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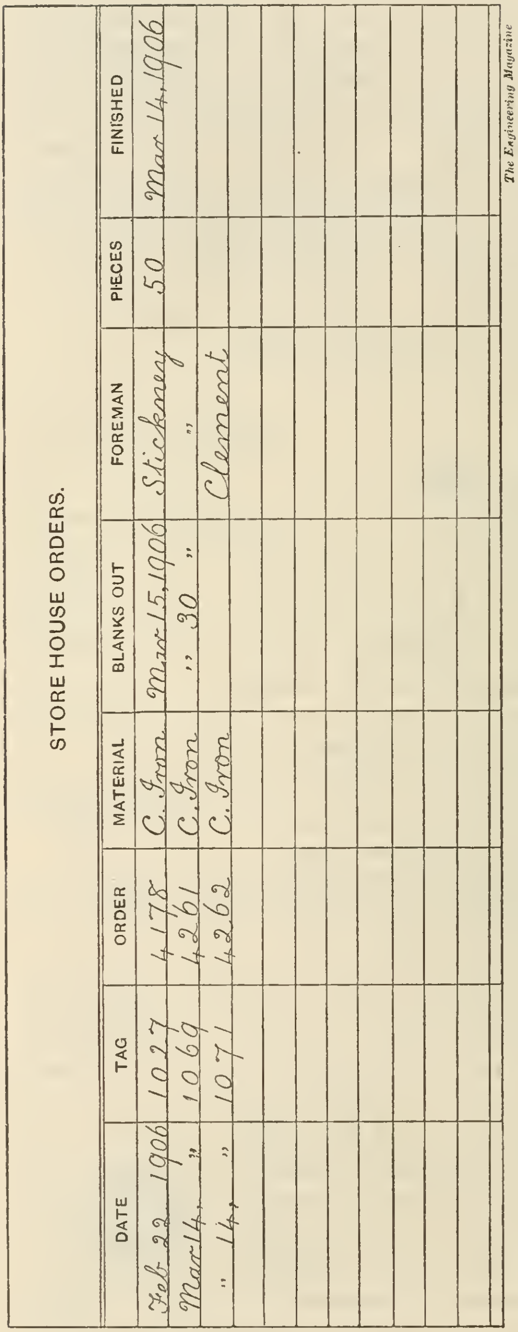
FIG. 5. FILE TAG. ATTACHED BY STORES KEEPER TO SAMPLE WHEN ORDERING SPARE PARTS FOR STOCK.

Partly filled out in his handwriting, and completed in the shop office. The tag is a plain manila stock. The "Sample Tag" and "Blank Tag" (See references just below on this page) are similar, except for name in the upper left corner; but the Sample Tag is brilliant yellow and the Blank Tag a vivid red

In ordering, the stores keeper sends a finished sample of the piece wanted to the shop office. To this sample is attached a "File Tag" (See Figure 5) which has been partially filled out, a corresponding entry having been made in the stores keeper's books. At the shop office a clerk finishes filling out the "File Tag," as indicated by the different handwritings in Figure 5, and fills out the "Sample" and "Blank" tags. A triplicate shop order is also made out, and one copy sent to the foundry with the sample, to which are now attached the "Sample" and "Blank" tags. A second copy of the order goes to the finishing department, and the third is filed in the shop office, a corresponding entry being made in the books. The "File" tag is returned to the stores-keeper. All interested parties now have a com-



STORE HOUSE ORDERS.

DATE	TAG	ORDER	MATERIAL	BLANKS OUT	FOREMAN	PIECES	FINISHED
Feb 22 1906	1027	4178	C. Iron	Mar 15, 1906	Stickney	50	Mar 14, 1906
Mar 14 "	1069	4261	C. Iron	" 30 "	"		
" 14 "	1071	4262	C. Iron		Clement		

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FIG. 6. HEADING, RULING, AND SAMPLE ENTRIES IN SHOP BOOK FOR STOCK-ORDER RECORDS.

The original is 8½ inches wide, ruled in red and blue.

plete record of the order which fully outlines its course through the various departments.

When the first lot of blanks from the foundry is delivered, the original sample, with "Sample" tag attached, is sent with them to the finishing department; the "Blank" tag is attached to a blank and retained at the foundry until all required blanks are made, when it accompanies the last lot to the finishing department. Each lot of blanks delivered is entered on the back of the "Blank" tag, and these entries should tally with the entries made for each lot of blanks received, on the back of the "Sample" tag by the foreman of the finishing department. In case the stores keeper runs short of stock before the completion of an order, small deliveries are made direct to the mills, and all deliveries from the finishing department are therefore entered on the back of the "Sample" tag. When the final delivery of the order is made, the original sample and tag are sent to the stores keeper, who signs the tag and returns it to the shop office, thus receipting for the completion of the order.

When the blanks are all out of the foundry the foundry order copy, with the number and weight of castings made entered on its face, is returned to the shop office, and by means of the tags returned from the store house, the shop office is thus advised of the completion of each stage of the order. Corresponding entries made in the shop books (See Figure 6) indicate the progress of all orders in process. To guard against accumulation of unfilled orders in any department, a monthly statement is made out for each foreman, which explains itself. (See Figure 7.)

In description this system may appear complex, but in operation it is extremely simple, and the clerical work, being distributed through several different departments, is scarcely noticeable. The samples and blanks, with their colored tags, are kept on special shelves, and thus present to the eye of the foremen and superintendent a constant index of the state of this class of work in each department.

In an earlier contribution to THE ENGINEERING MAGAZINE, I have given a description of the method then in use in this shop for conducting a premium system in conjunction with regular or day work. This system has been conducted with uniformly good results, with but one radical change in method, namely the adoption of the Rowan system of determining premiums in place of the modified form of the Halsey system which was formerly used. Under the Rowan System, to earn a premium in excess of his regularly hourly or daily wage, the workman is required to complete each piece at the rate of less than (t) minutes. If in total time (T) minutes he completes (N) pieces he will receive, in addition to his regular wages a bonus or premium of minutes, paid for at his usual rate, expressed by the formula:

$$1 - \frac{T}{tN} T$$

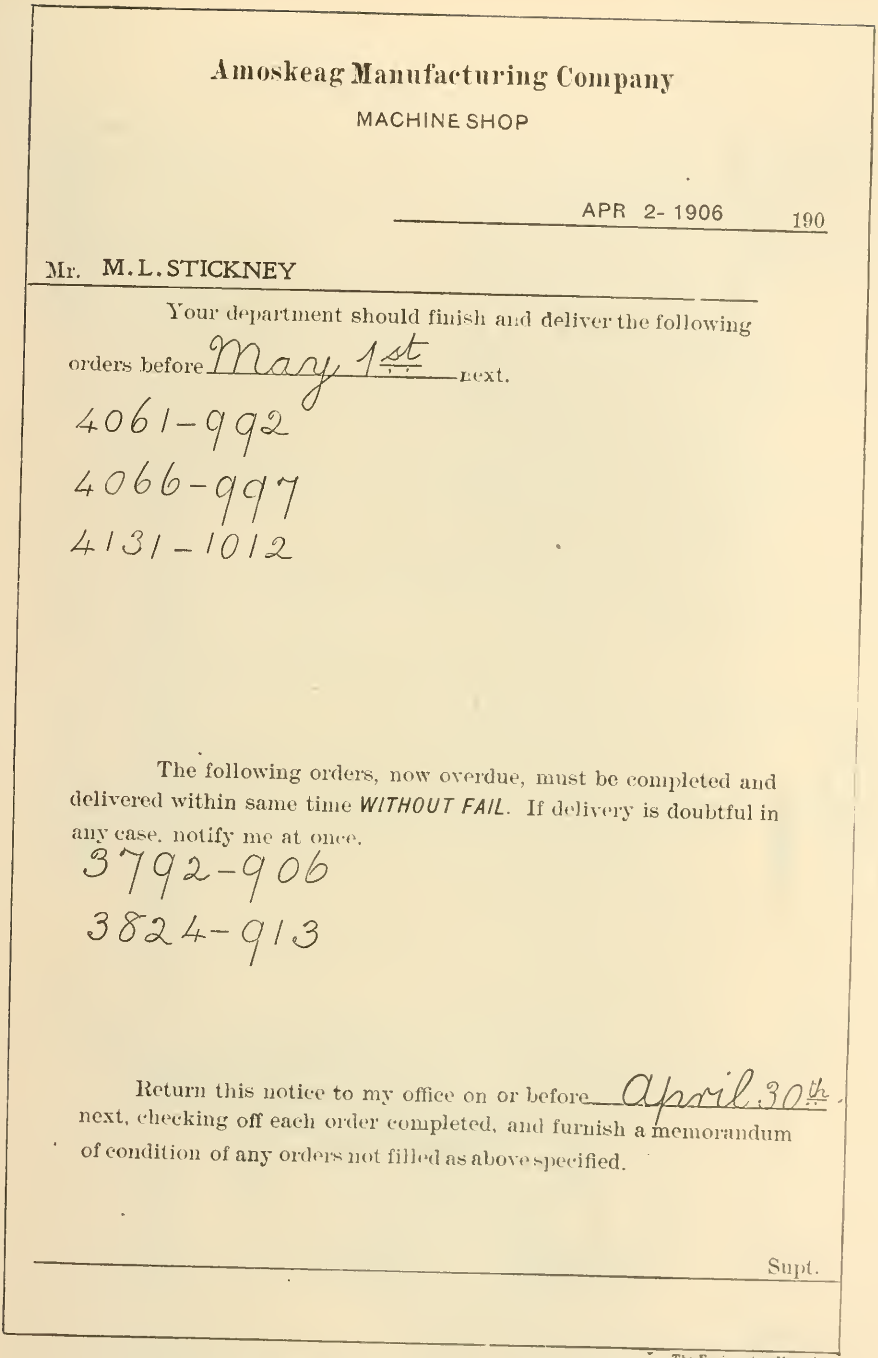
Thus, if a workman in 10 hours finishes 60 pieces, the stipulated rate being 12 minutes per piece, his premium is:

$$\left(1 - \frac{600}{12 \times 60}\right) 600 = 100$$

minutes, or 1 2-3 hours. This is of course equivalent to a premium of 16 2-3 per cent paid for an increased production of 20 per cent. By the same system an increased production of 25 per cent earns 20 per cent, and 100 per cent earns 50 per cent. Up to 100 per cent, or doubled production, the earnings under this system exceed those under the Halsey system on a 50 per cent basis. At doubled production the two systems pay the same premium, but beyond this point earnings under the Rowan system fall below the Halsey system and approach 100 per cent or "double time" as a limit.

The reasons for the adoption of the Rowan system are as follows: In many cases, notably in wood working and in performing simple machine-tool operations on large numbers of small parts, the rate of production depends more upon the manual dexterity and industry of the operative than upon the time required for the actual machining operations. In such cases accurate estimation of time is extremely difficult, as speeds and feeds become minor factors in the equation. Consequently, under the Halsey system, unreasonably large earnings would sometimes result even where estimates were carefully made from the best data at hand. Under any premium system, large earnings always represent a diminished cost of production and are therefore, in a sense, not a direct loss to the employer; nevertheless, if unreasonably large they endanger the harmonious working of the system as they are sure to cause dissatisfaction among the less fortunate operatives. Unreasonably large earnings, then, must be avoided, but never by any means unfair to the operative, such as cutting rates —an expedient which is dangerous in the extreme and which has never been resorted to in this shop. The Rowan system solves this problem by paying a high rate for small increases, thus recompensing the workman if the estimate has been too closely made, and by paying a lower premium for very large increases, thus protecting the employer from the evil results of too liberal estimates. In my opinion this system is by far the best for shops in which the volume of work does not warrant the maintenance of a special estimating department, or where the nature of the work is such that estimating is abnormally difficult. Its only objectionable feature is that it puts a premium on loose or careless estimating, but proper supervision should guard against this and all such defects.

Premium work in connection with day work has one great advantage which seems to escape general recognition, namely that a man engaged part of the time on day work and part on premium work is in reality on premium work all the time, for the increased earnings possible on the premium work, which he knows awaits him, stimulate him to complete his day work as rapidly as possible. This



Amoskeag Manufacturing Company

MACHINE SHOP

APR 2- 1906 190

Mr. M.L.STICKNEY

Your department should finish and deliver the following orders before May 1st next.

4061-992

4066-997

4131-1012

The following orders, now overdue, must be completed and delivered within same time *WITHOUT FAIL*. If delivery is doubtful in any case, notify me at once.

3792-906

3824-913

Return this notice to my office on or before April 30th next, checking off each order completed, and furnish a memorandum of condition of any orders not filled as above specified.

Supt.

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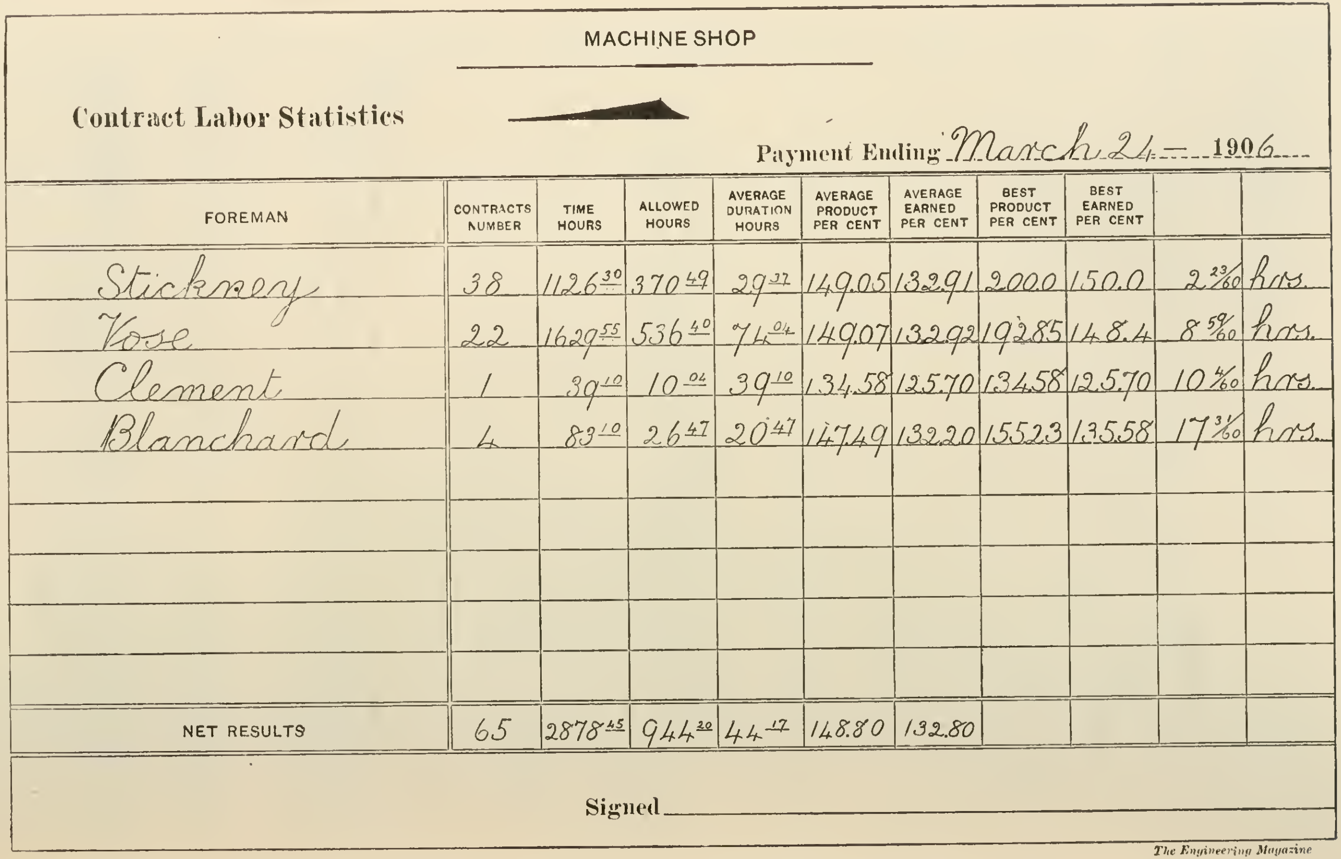
FIG. 7. MONTHLY STATEMENT OF PENDING ORDERS. MADE OUT BY SHOP OFFICE AND ISSUED TO FOREMEN.

Original is a card 5½ by 8 inches.



MACHINE SHOP

Contract Labor Statistics

Payment Ending March 24 — 1906

FOREMAN	CONTRACTS NUMBER	TIME HOURS	ALLOWED HOURS	AVERAGE DURATION HOURS	AVERAGE PRODUCT PER CENT	AVERAGE EARNED PER CENT	BEST PRODUCT PER CENT	BEST EARNED PER CENT		
Stickney	38	1126^{30}	370^{49}	29^{37}	149.05	132.91	200.0	150.0	$2\frac{23}{60}$	hrs.
Vose	22	1629^{55}	536^{40}	74^{04}	149.07	132.92	192.85	148.4	$8\frac{59}{60}$	hrs.
Clement	1	39^{10}	10^{04}	39^{10}	134.58	125.70	134.58	125.70	$10\frac{4}{60}$	hrs.
Blanchard	4	83^{10}	26^{47}	20^{47}	147.49	132.20	155.23	135.58	$17\frac{31}{60}$	hrs.
NET RESULTS	65	2878^{45}	944^{20}	44^{17}	148.80	132.80				

Signed

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FIG. 8. REPORT OF MAXIMUM AND NET RESULTS OF PREMIUM WORK.

The last column gives the duration of the contract on which the best earnings were made in each department.

circumstance works to the advantage of both employer and operative, and from experience I am assured that it is by no means a theoretical advantage; for, in departments where both systems are used, the day work proceeds with much greater diligence on the part of the operative and much less " driving " on the part of the foreman, than was ever attained before the introduction of the premium system.

The net results and maximum results of premium work are easily traced by a simple report made out at the end of each payment for the inspection of the superintendent. (See Figure 8.)

The beneficial effect of the premium system in simplifying shop supervision is indubitable. The amount of time required of foremen for estimating and inspecting is quite appreciable, it is true, but for every hour spent in this manner, two were formerly spent in " driving " the help to maintain a production not nearly as good, while the difference in time expended is now available for proper supervision, improvements in method, etc.

I believe that in any shop where the problem is approached in a spirit of fairness both by employer and employed, no real difficulties exist which make the use of the premium system impracticable. Tentatively and carefully introduced, with a few men of known reliability, the time should soon come when all will ask for premium work instead of avoiding it, and its success is then assured.

MACHINERY AND PROCESSES IN A MODERN PORTLAND-CEMENT PLANT.

By F. H. Lewis.

I. THE PURSUIT OF ECONOMY IN KILN PRACTICE.

We pointed out recently (in connection with Mr. Eckel's article upon "Cement Production and Manufacture in the United States", which appeared in this Magazine for February last) that the enormous expansion of the cement industry was one of the most significant things in the engineering progress of the times. It is intimately related to the growth of the steel industry, and reflects a revolution in construction methods. Mr. Lewis' theme is principally concerned with the parts played by the metallurgical chemist and the mechanical engineer in enabling this phenomenal development.—THE EDITORS.

IN dealing with this subject reference will be made entirely to the rotary kiln and to American methods—which are rapidly becoming European methods.

The principal raw material used by a cement kiln is atmospheric air. To produce a barrel of cement by the dry method requires 600 pounds of ground rock, 110 pounds of powdered coal, and about 2,000 pounds of air. Of this air only about 260 pounds actually contributes to the generation of heat. The balance is inert matter forming part of the gaseous contents of the furnace. It must be raised to the clinkering temperature of cement by the combustion of fuel, exactly as the ground rock is. As the specific heat of air is not very different from that of the cement composition, this means that the air takes up rather more than two and a half parts of the heat generated by combustion to one part taken up by the raw material proper, and in a rotary kiln it does not yield this heat again to advantage. A part of the whole amount of heat generated is also lost by convection and radiation, and as a net result in ordinary practice less than one-fourth of the heat generated in a kiln is used in clinkering the cement composition.

This statement, too, must be understood as a practical fact. It has no reference to the theoretical value of the fuel, but to the distribution of the heat as actually utilized in kiln practice. There appears, therefore, to be an enormous practical waste of fuel. A part of this, however, is inevitable. So far as combustion proper is concerned analogous results are obtained in boiler and other furnaces by reason of air dilution. But in a rotary kiln this great volume of heated gases is very badly utilized. Something like 45 per cent of the total heat passes off with the flue gases, while about 12 per cent more passes out at the lower end as the sensible heat of the clinker. Hence this type of kiln requires twice the fuel which is necessary to burn clinker in the best types of continuous shaft kilns.

If all this waste heat could be utilized it would generate 70 per cent of all the steam power required by a cement plant. Or it would heat all the air entering the kilns to an initial temperature of 1,800 degrees and cut the fuel bill in half. It cannot all be utilized, of course, and the advantages of the rotary kiln in other respects are such as to make it advantageous in many places, regardless of the waste of fuel. But this great by-product of unused heat cannot be overlooked if economy of production is to be fully developed; nor indeed has it been, as will appear below.

As other by-products of cement manufacture, for each barrel (380 pounds) of clinker produced, there is given off from the chimney 440 pounds of carbonic acid, 10 pounds of sulphuric acid, and 6 pounds of potash and soda. These by-products exceed in weight, and if they could be utilized would exceed in value, the primary product of manufacture.

All human endeavor proceeds by methods of trial and error. Seldom is a proposition approached first-off, either logically or advantageously. We learn by a series of mistakes, and there are few pieces of machinery which have developed through a more conspicuous series of blunders than the rotary kiln. Neglecting its early history in England and America, which has been so often recited, we find it in successful operation at two plants in the United States in 1892. These were the Atlas plant at Coplay, Pa., and the Alpha plant at Alpha, N. J. By successful operation, I mean that the kilns were regularly producing an excellent product. Commercially it is doubtful whether they were satisfactory even at the high scale of prices of those days. These kilns were small and the fuel was crude petroleum. It required from 10 to 15 gallons of oil to produce a barrel of cement, and the clinker, while of superior quality, was much more difficult to grind than the old-style product.

Immediately we find attention being given, not to better means of utilizing the heat, but to utilization of the by-products, to wit, the waste heat and waste gases. Mr. J. F. deNavarro of the Atlas Company took out a series of patents for this purpose. Figure 1 is an illustration taken from patent No. 11,224 issued to J. F. deNavarro in 1892. It provides for all the usual features of a rotary kiln shown in the upper part of the drawing, and in addition for a revolving cooling cylinder below the kiln. This cooling cylinder enters the hood which closes the lower end of the kiln. The specification recites: "By causing the air to pass over the heated product in the cylinder G while the said product is kept in motion, the material is very effectively cooled and the waste heat abstracted from it is used to the best effect in heating the air supplied to the furnace." It is an attempt to utilize the waste heat of the clinker, which at that time probably did not exceed 8 per cent of the whole.

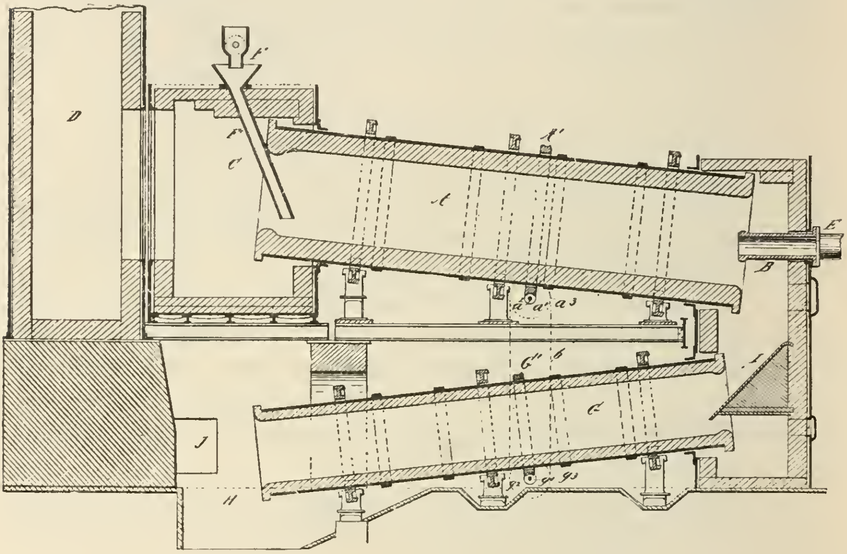


FIG. 1. DE NAVARRO'S PATENT OF 1892.

Figure 2 is taken from patent No. 457,589, issued to Mr. de Navarro in 1891. In addition to the features shown in Figure 1 it has a hot-air stove in the dust chamber at the upper end of the kiln. Air passes

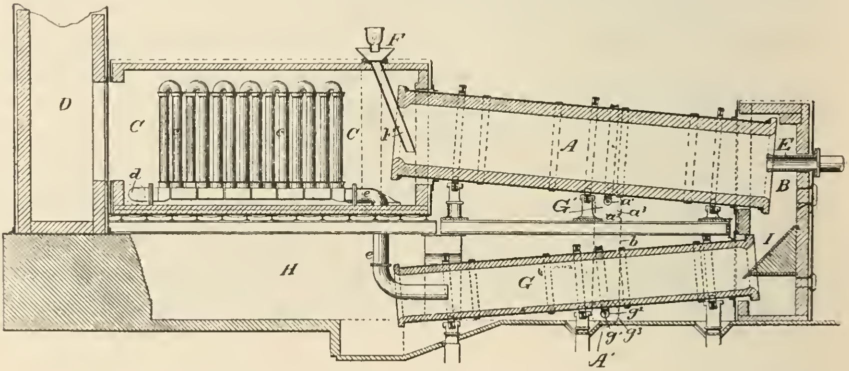


FIG. 2 DE NAVARRO'S PATENT OF 1891.

first through this stove, then to the cooling cylinder, and thence enters the kiln. This device endeavors to utilize both the waste heat of the chimney gases and the heat of the clinker. So far as is known these devices effected no economy in fuel worth considering. The cooling cylinder was doubtless a good thing. We find it developed further in a patent granted in 1895 to Messrs. Hurry and Seaman (also of the Atlas Cement Co.), shown in Figure 3. This has the cooling cylinder of Mr. de Navarro's earlier patents, but is a clinker-cooling device pure and simple. The hot clinker drops onto water-cooled rolls which break it up; thence to the cooling cylinder, where more water can be added if desired. An endeavor is made to make an air-tight connection between the cooling cylinder and the hood so as to perfect the draft, and provision is made for an artificial current of air in the cooling cylinder by means of a fan. Nothing is claimed for fuel economy and the fan is not used to supply air for the kiln. This patent is no doubt a valuable one for clinker-cooling purposes, and is a feature of large plants built by the Atlas Company in later years.

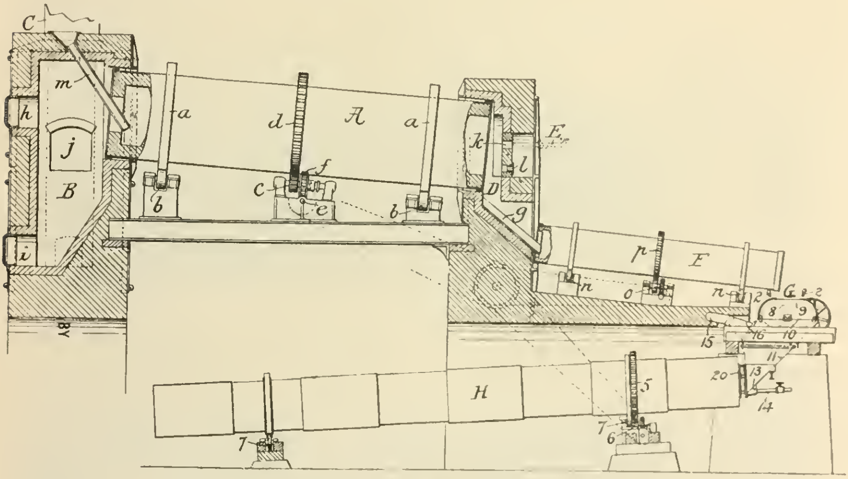


FIG. 3. HURRY & SEAMAN'S PATENT OF 1895.

In 1896 Mr. deNavarro took out a patent for utilizing the carbonic acid from cement stone. Figure 4 is from this patent (No. 560,742). The carbonic acid is driven off by a retort furnace and collected in a condenser chamber T before the material goes to the kiln proper. So far as is known, neither this patent, nor others taken out with like intent by various individuals, has had any practical value.

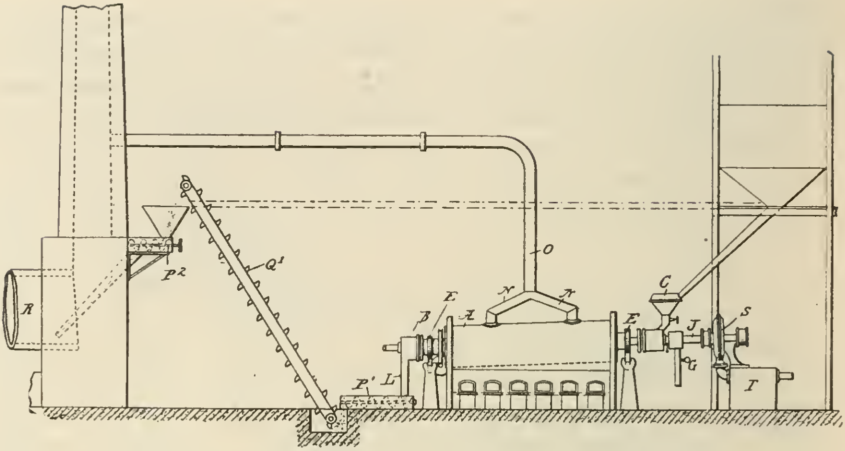


FIG. 4. DE NAVARRO'S PATENT OF 1896.

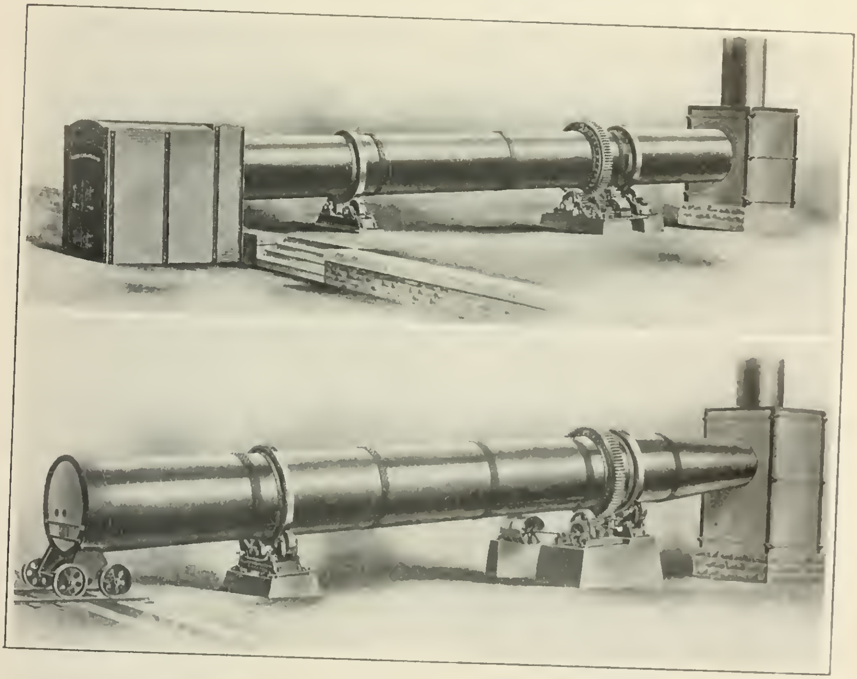
In 1896 a plant was built at Nazareth, Pa., in which an ambitious attempt was made to utilize the waste heat of the flue gases for generation of steam. From the dust chambers of the kilns the flue gases passed directly to vertical water-tube boilers which furnished steam for engines driving the grinding mills. Seven kilns were installed in this way. There was not, of course, sufficient waste heat to generate the steam required, so auxiliary firing of the boilers had to go on continuously. This interfered with the draft of the kilns and greatly reduced their output. The fire-room labor was as expensive as ever, the fuel saving small, and the plant produced neither clinker nor steam satisfactorily. A new steam plant was built, the old boilers were taken out, and the kilns were provided with independent stacks as usual.

An attempt was made by me in 1898-99 to draw off kiln gases and utilize them for drying stone, but the conditions were unfavorable and little or no advantage resulted. Later, in 1904, the Lehigh Portland Cement Co. equipped a new plant with this scheme. Four kilns out of ten were arranged to discharge the flue gases from the dust chamber into auxiliary cylinders in which the stone was dried. The arrangement complicated the handling of stone considerably and increased the fuel consumption of the kilns. The advantage, if any, was so inconsiderable that the experiment has not been repeated.

A variety of devices have been tried for heating the air which carries the coal feed. This has been done both by passing the air through the hot clinker and by heating it in the dust chamber. No important advantage has been gained in this way, and in some cases the installations were so unsatisfactory that it was imperative to take them out.

The heat of flue gases has also been utilized in several plants by installing economizers in the dust chamber or at the base of kiln stacks. Whether or not any advantage has been gained over the usual practice of placing the economizers in the boiler stacks I am not advised. The disadvantage which has been a feature of nearly all the devices described above is that they complicate the kiln plants proper and gain advantage in other respects by inconvenient arrangements badly placed for the work required of them.

Lastly, the advantages and disadvantages of collecting by suitable devices the alkaline vapors in kiln gases have been discussed in the chemical societies and apparently found to be an interesting topic. An ordinary ten-kiln plant discharges five or six tons of potash and soda into the atmosphere daily. Can this be collected economically without disadvantage to the kilns? Undoubtedly someone will make the attempt before long and may succeed. But as a rule, those best posted are willing to let someone else do the experimenting.

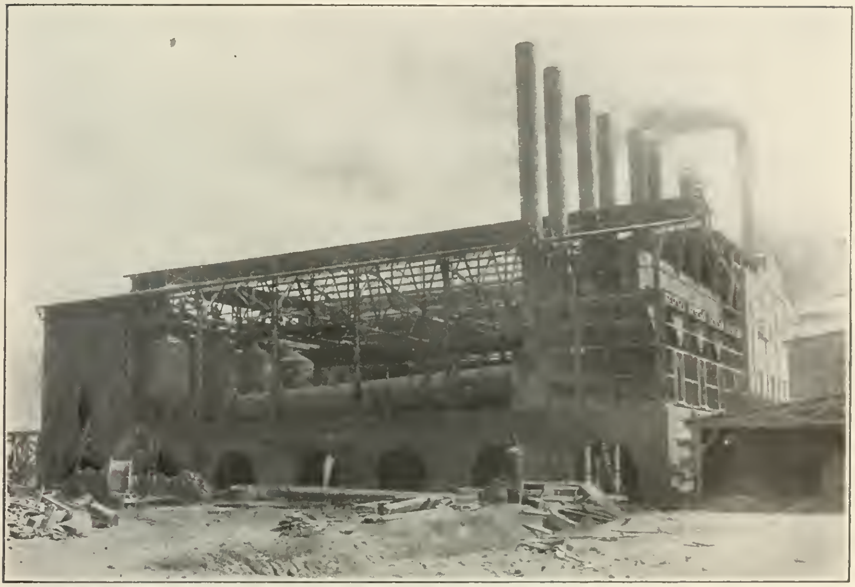


MODERN TYPES OF ROTARY KILNS AND DRYERS.
The dryer above, the kiln below. Allis-Chalmers Co., Milwaukee, Wis.

It will be noted that the minds of most men have been devoted more to the utilization of heat as a by-product than to using it most advantageously in the primary operation, to wit, the production of clinker. It is true kilns have been gradually improved and perfected, made larger and longer, equipped with better feed devices, etc. But we have been slow to adopt the principles found advantageous in other forms of furnaces and have found it difficult to shake loose certain ideas long considered essential by cement makers. For example, the necessity for an oxidizing flame in the kiln and the supposed necessity for a clinkering zone of very high temperature to form the tricalcic silicate so much insisted upon by doctrinaires. We know that in boiler practice, to get out the heat developed in the furnace we must have adequate heating surface. In a metallurgical furnace economy results from a long flame and a high flue-bridge (or a small opening over the flue-bridge). We have been slow to learn similar practice in a cement kiln.

The old rotary kiln was 5 feet in diameter and 40 or 45 feet long. It was set at an inclination of ¾ inch to 1 inch per foot, and revolved very slowly. The heating surface was small because the area in contact with the heated gases was so limited, and because of the steep

CEMENT KILNS UNDER CONSTRUCTION. THE LOWER OR BURNER END, WITH BRICKWORK FOR HOODS IN PROGRESS.

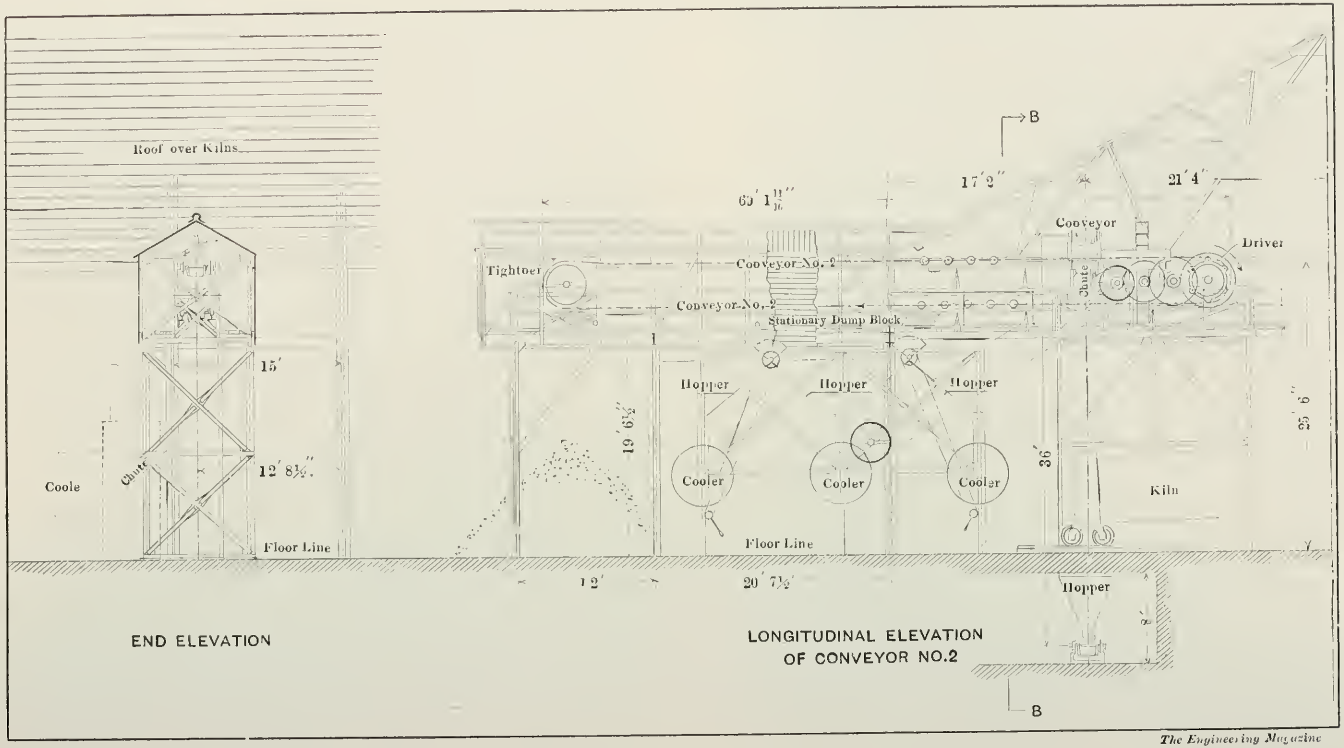


A KILN HOUSE IN PROCESS OF ERECTION.

The Kilns are 6 by 60 feet. Stock boxes and coal tanks plainly shown. Plant of the Virginia Portland Cement Co., Fordwick, Va.

pitch and slow speed the material was not brought sufficiently in contact with the hot gases. Impressed with this latter point, I designed and built kilns for two different plants in 1899 which had only ½ inch pitch per foot and 50 per cent greater speed of rotation than usual. This meant that in passing through the kilns the material was 50 per cent longer in contact with the heated gases than in the old kilns; its forward movement was the same while the rotating, stirring, or tumbling motion was more rapid. Kilns are now being built with ⅜ or even less pitch and correspondingly greater speed of rotation. They are being built larger and longer to provide additional heating surface, lower pitch, and greater speed to bring the material more often in contact with flame and hot gases.

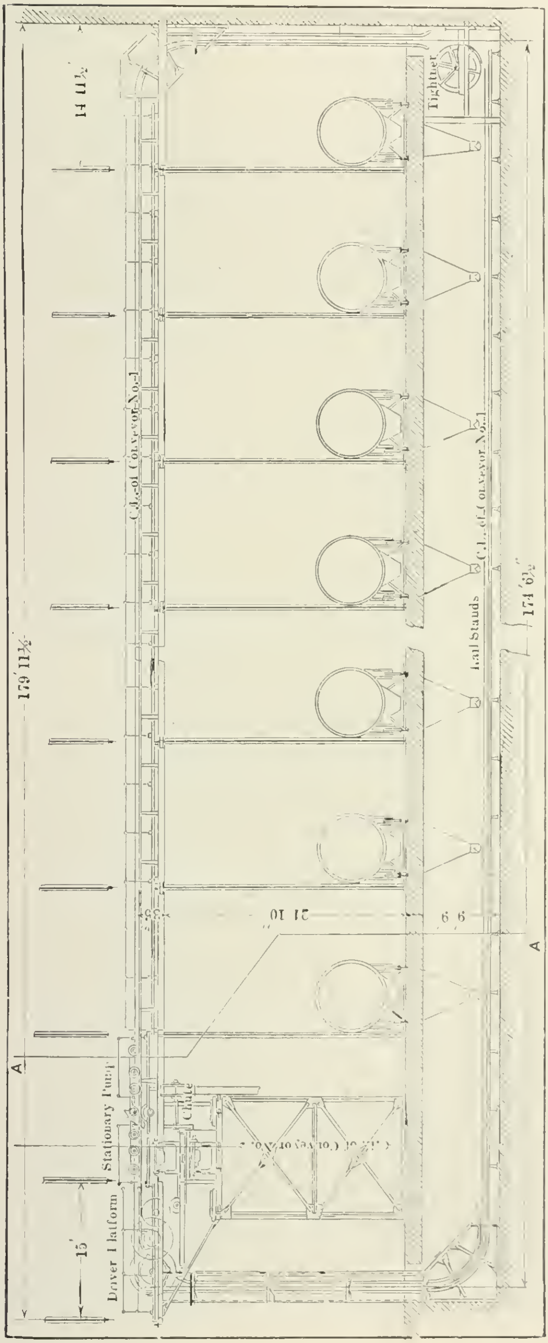
We are revising our ideas somewhat also on chemical reactions. Assuming properly prepared raw materials practical experience leads us to believe that the production of Portland-cement clinker is merely a question of subjecting this material to a sufficient degree of heat for a suitable interval of time. Heat and time vary with different materials; for any given material they vary inversely to each other. The temperature limits may vary between 1,700 degrees F. and 3,300 degrees, and the time required for satisfactory chemical reaction may be of indefinite extent or it may be instantaneous. Lime and silica



The Engineering Magazine

GENERAL ARRANGEMENT OF PLANT OF ALPHA CEMENT CO., MARTIN'S CREEK, PA.

Showing especially the run of the 18 x 24 inch conveyors as installed by John A. Mead Mfg. Co. For section B B see the diagram opposite.



The Engineering Magazine

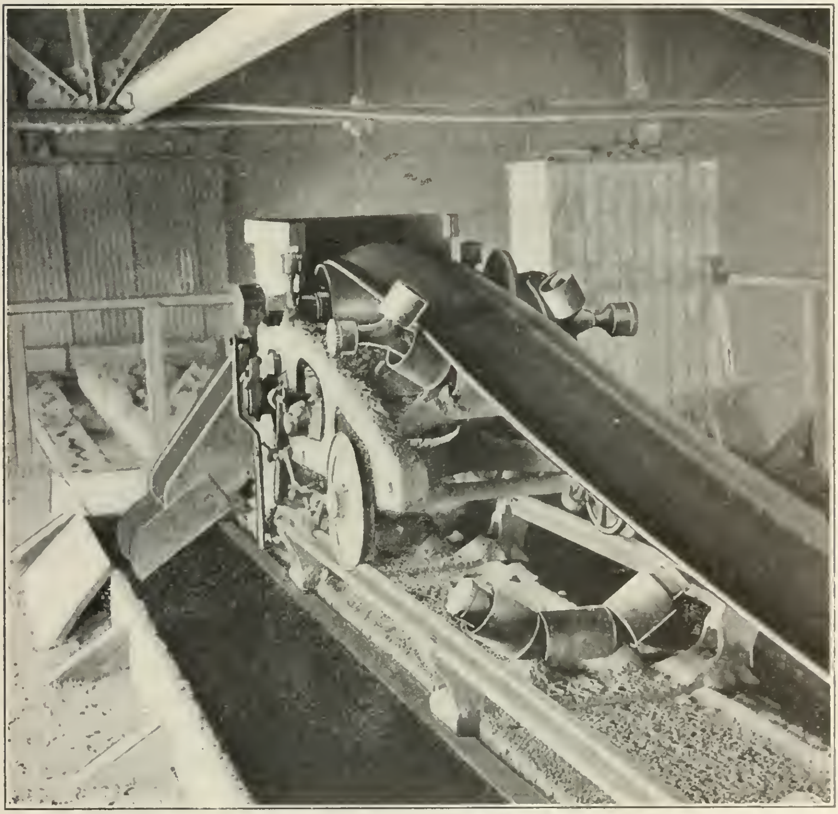
PLANT OF THE ALPHA CEMENT CO. FOR SECTION AA SEE THE DIAGRAM OPPOSITE.

Installed by John A. Mead Mfg. Co.

will combine superficially at ordinary temperatures. Lime will combine more or less perfectly (depending on mechanical contact) with any clay which has been heated to redness. In a Portland-cement kiln we have an intimate mixture of carbonate of lime and of clay. The clay becomes chemically active at about 1,100 degrees F. The carbonate of lime yields up its carbonic acid and becomes quicklime at 1,700 degrees. Combination between the two materials is found to begin the moment quick-lime finds itself in contact with chemically act-

KILN ROOM, CEMENT PLANT NO. 3, ILLINOIS STEEL CO., BUFFINGTON, IND.

Rotary Kilns installed by the Allis-Chalmers Co.

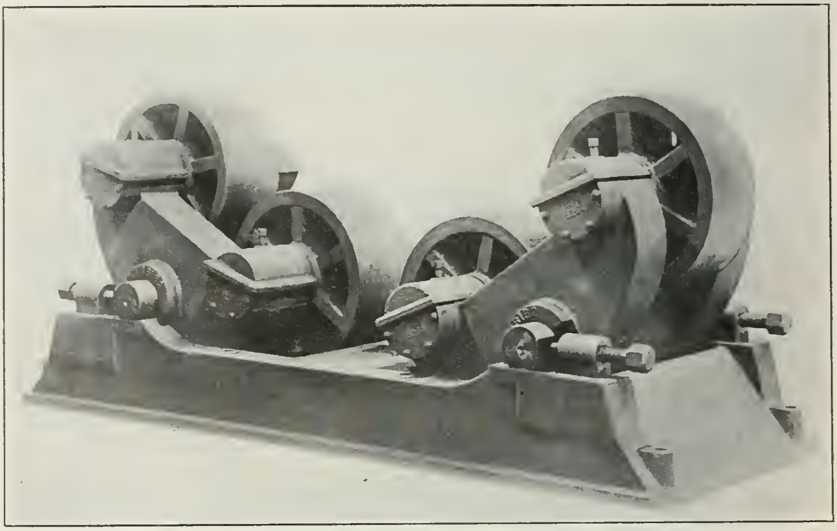


AUTOMATIC SELF-REVERSING TRIPPER, DISCHARGING GROUND CLINKER TO BINS.

Installed at the plant of the Alpha Portland Cement Co., by the Robins Conveying Belt Co.

ive clay. The higher the temperature the more rapid the combination. At the temperature of an electric furnace it is fair to conclude that it would be instantaneous. At a uniform soaking heat the time required increases as the temperature decreases, but nevertheless goes on progressively at lower temperatures than were formerly considered necessary.

We do not discuss so much whether the formation of tricalcic silicate is necessary or whether it is not. If it is necessary, then we form it, but we do it somewhat differently from the way in which we have been told we should. Practical experience shows that at comparatively low temperatures chemical unions are formed which are hydraulic, and that with higher temperature or more prolonged baking these combinations become more perfect and exhibit greater chemical activity.



CARRYING MECHANISM WITH FOUR ROLLERS AND EQUALIZERS FOR ALLIS-CHALMERS ROTARY KILN.

Two things enter a rotary cement kiln; raw material in a fine state of subdivision at the upper end, powdered coal at the lower end. The one product of the kiln is cement clinker. Its by-products are the sensible heat of the clinker, the waste heat of the flue gases, the carbonic acid, sulphuric acid, and alkalies carried off with the flue gases. It may yet be that important advantages will be gained by utilization of by-products. It is only fair to say, however, that the results of experiments, up to this time, are distinctly discouraging. The modern cement-maker pins his faith to better utilization of heat to obtain his primary product. More heating surface, more frequent contact of material with heated gases; a larger kiln, a longer kiln, a long flame and a soaking heat. These things are yielding more output, better cement, and more economical product.

ORGANIZATION AND ECONOMY IN THE RAILWAY MACHINE SHOP.

By H. W. Jacobs.

I. SPECIALIZING AND CENTRALIZING THE OPERATIONS AND EQUIPMENT.

Because the railway shop is not competitive, it has been slow to feel the pressure for lowered expense of production. It did not have to measure its costs against energetic and alert business rivals. Lately, however, there has been a great awakening, and some of the large American Transcontinental roads have gone as far perhaps as any commercial establishment in studying to bring their work down to a minimum cost per unit.

Mr. Jacobs is one of the leaders in this movement, and the methods he describes have been tried out in the shops of one of the greatest Transcontinental lines. Everything he suggests is practical—the result of thorough trial and perfection under working conditions. And in the following papers especially, his illustrations tell a story as valuable as that of the text.—THE EDITORS.

RAILROADS in the United States perform the functions of common-carriers and of money-makers. As carriers, besides their relation to the land and the people, they must be adapted to the trade of their territory and connections—in facilities, capacity, and operative efficiency. As the property of private persons, they must be managed and operated to effect the greatest ratio of net earnings to investment, besides conforming to the compulsions of the law, and to their own interests in commerce. Men trained as engineers in both the schools of induction and of practice, are as a class best able to bring about these results, as their work is constructively directed toward the end in view after intelligent analysis of actual conditions. We shall deal with some concrete problems of the engineer in relation to the maintenance of operative efficiency of the motive power and rolling equipment—those most active factors of earning power and expense in existing steam roads.

To move the traffic of a road, locomotives and cars are required. These must be built, maintained in running order, repaired, replaced, and must be designed with reference to safety, efficiency and operative economy, cost, adaptability, durability, simplicity and interchangeability of parts, and facility of repairs.

Whether a road builds its own equipment or not it has a large voice in specifying design, and it must keep up the running condition; these functions require both the mechanical and the industrial engineer.

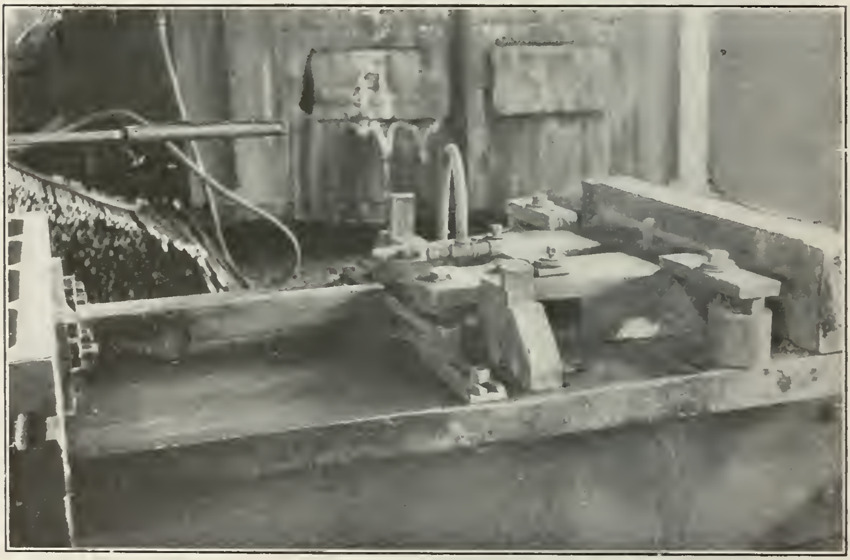
Great manufactures, such as the steel industry, have been successful on a large scale. The methods under which they thrived are applicable wherever there are manufacturing shops. Railroads have been slow to modernize their shop methods and to refine their mechanical practice, because the chief spur is to earn dividends by means of transportation. They are only very indirectly affected by the forces governing competitive and economical manufacture in commercial enterprises, and less indirectly by the forces making for greater serviceability of equipment. But if the experience of the commercial manufactories is profited by, and modern methods adopted wholesale, modified to suit such conditions as may be peculiar to railroads; if the improved products, developed at such cost in the commercial world, are but taken as they are found, and used effectively, great improvements in operative and maintenance efficiencies and economies will ensue, resulting in the two-fold gain of lowered running cost and fixed charges, together with capacity for handling larger business, with greater gross, and redoubled net, earnings.

All this is not mere argument, but is demonstrated by actual instances, late and near at hand. The management of the roads are waking up to these capabilities and rapidly availing themselves of them. Cast steel and malleable iron are substituted for cast and wrought iron, wherever they may with advantage be used. Patterns are redesigned, reclassified, and standardized, many being obsoleted, surplus of material being done away with both on account of the needless higher first cost of the casting, and the increased time of machining; bolt holes are cored so as not to require drilling, and design is strengthened to take care of weaknesses shown by exhaustive records of all classes of breakage to parts of motive power and rolling equipment; locomotive and car elements are standardized as far as practicable, and new equipment is ordered to conform to these specifications. The Harriman lines and the Rock Island have been conspicuous examples of such standardization, broadly conceived and comprehensively carried out.

Tests are becoming more thorough and less perfunctory, and as a result, design is continually changing for the better. Not only is there thus a general tendency toward improvement in quality and efficiency of equipment, but there is also a growing determination to provide the very best shop facilities for taking care of repair and replacement, as at the Moline (Rock Island), Topeka (Santa Fé), Collinwood (Lake Shore), Omaha (Union Pacific), and other large recent shops. And in these shops, centralized, large, there is a growing effort toward intelligent systematization of manufacture, toward rapid production at low cost, and toward using men and machines to full economical capacity.

The direction in which the railroads are slowly moving is the right one; this paper advocates some of the means by which these results can be attained in a still larger way.

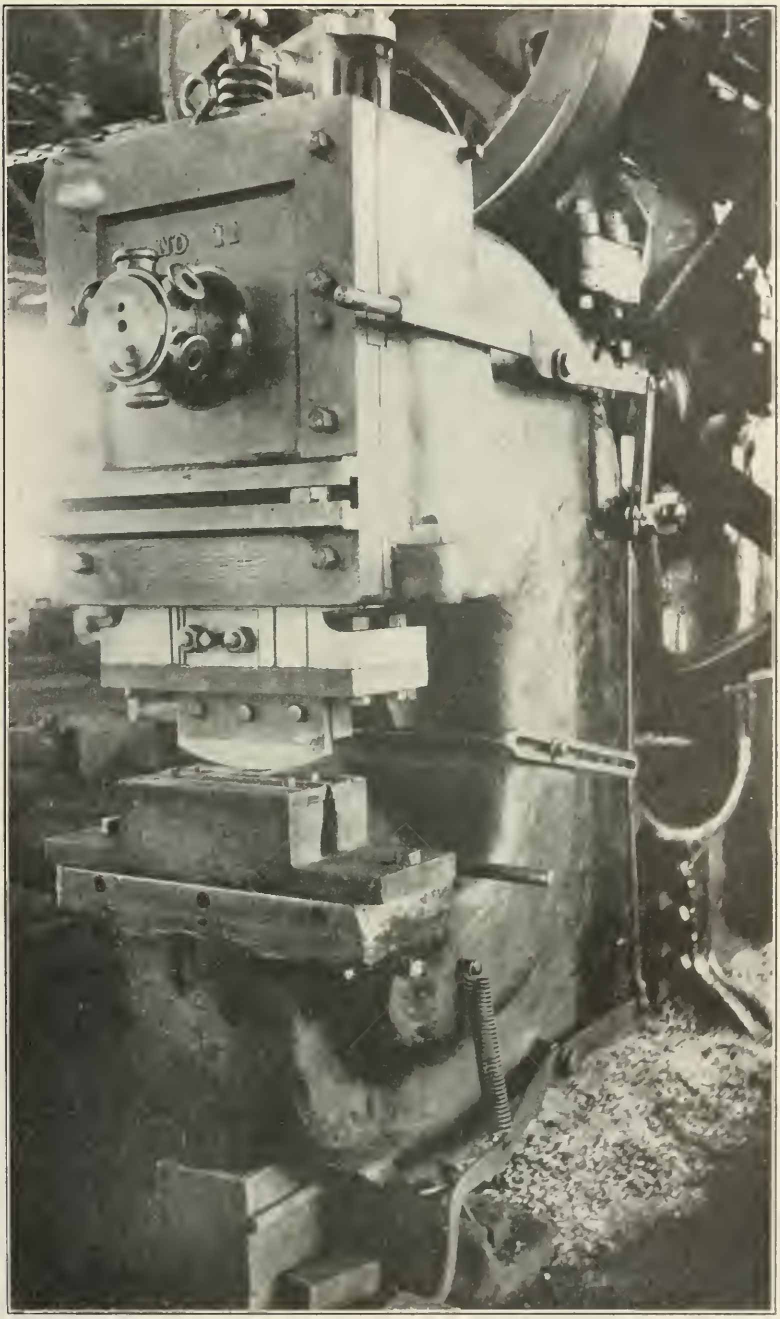
In the first place, salaries and wages are too low. I am no advocate of increased pay rolls. But it is shown in practice that five men worth $4.00 a day each can do as much as ten $3.00 men, and the same is true of a foreman earning $80.00 or $90.00 compared to one earning $150.00 to $200.00; or of an officiai belonging to the $200.00 class compared to one belonging to the $600.00 class. The high-priced man is not necessarily the best; but for the high price the best can be secured. It is manifestly false economy to pay a master mechanic $175.00 a month, and give him charge over one thousand or two thousand men with an aggregate pay roll of $60,000 to $100,000, when an intelligent $300.00 man, bringing perhaps in his train a $500.00 staff of assistants and specialists, can in six months lop off 15 to 30 per cent of this pay roll, and at the same time by system and specialization and a method of reward according to merit, give increased and better service. Similarly, a $90.00 foreman is not an economical man to whom to entrust the requisitioning of thousands of dollars worth of material each month; he will generally order perfunctorily and far beyond his needs, and it is not usual for his requisitions to be effectively checked up. There is, for example, the case of a road that had but two engines of one particular class, under experiment, which they would transfer from one division to another to get figures on their service. After they had been in use about two years and had been overhauled in three different places, the president called for an itemized expense statement; and when the supplies were checked up at the different stores, there were found to be fourteen sets of grates, nine sets of cylinder-heads, four sets of pistons, two complete sets of rods, besides numerous cylinder-head casings, valve packings, piston rings, etc.—more stock, in fact, than these two engines would use in ten years of hard service. This is perhaps an unusual case, but it is actual, and no one was to blame but the system. Each foreman at the different points thought it was his duty to keep up the supplies, and in a sense he was right, as no one wished to score a failure while the engine was in his particular territory. But if the foreman had been a man of good judgment, he would have consulted the storekeepers and others before ordering indiscriminately, and if there had been higher officials who would not have let such a condition come into effect, but would have permitted the ordering only of what was necessary, and would have intelligently transferred the material on hand as became requisite, all this needless investment in new material would have been obviated. Multiply this case by the number of engines on a road, and perhaps cut the total in two on account of its being an exceptional case, and the prevalent condition on many a road today will be pictured. Plainly, almost no salary is too high if it will secure the prevention and correction of this sort of practice.



A BRAKESHOE-KEY FORGING MACHINE DEVISED BY A BLACKSMITH-SHOP FOREMAN.

Reconstructed from an old bull-dozer. It forges two keys at a time from scrap car bolts, turning them out by the thousand at very little cost, where formerly they were made laboriously by hand. With the enormous number of keys used on a railroad handling a large freight business, an item of this kind is well worth considering.

There is now and then in a railroad shop a foreman whose ideas are of a special merit, which, if encouraged, can be of thousands of dollars benefit to a company. Such is the case of the blacksmith foreman who designed the brakeshoe-key forging machine here illustrated. This machine was reconstructed from an old bull-dozer and forges two brakeshoe keys at a time from scrap car bolts. Whereas these keys used to be made laboriously by hand, they are now turned out by the thousand at very little cost. With the enormous number of brakeshoe keys used on a railroad handling an immense freight business, an item of this kind is well worth considerable attention.



SHEAR USED TO CUT APART THE TWO KEYS WHICH ARE FORGED TOGETHER ON THE MACHINE SHOWN ON THE OPPOSITE PAGE

A FEW DAYS' WORK ON THE BRAKESHOE-KEY FORGING MACHINE.

Centralization, as applied to shop work in the railway world, is not exactly a new idea, although the subject has been more or less agitated by manufacturing concerns for years, and to this is largely due the success of some of our great modern trusts. But the development of this policy in railway lines is quite recent. The stride it has made in the immediate past, and which it is at present making among the railways of the United States, is worthy not only of comment, but of the serious consideration of every railway official who believes in "Economy and Efficient Service."

There are many things to be considered when taking up a proposition of this kind, involving serious and complicated problems which must be decided upon before a successful working basis can be established. First of all, should be considered the location of the railway in question, its mileage and general lay-out, and particularly the location of the division points and headquarters, shops, etc., with reference to *the original base of supplies.*

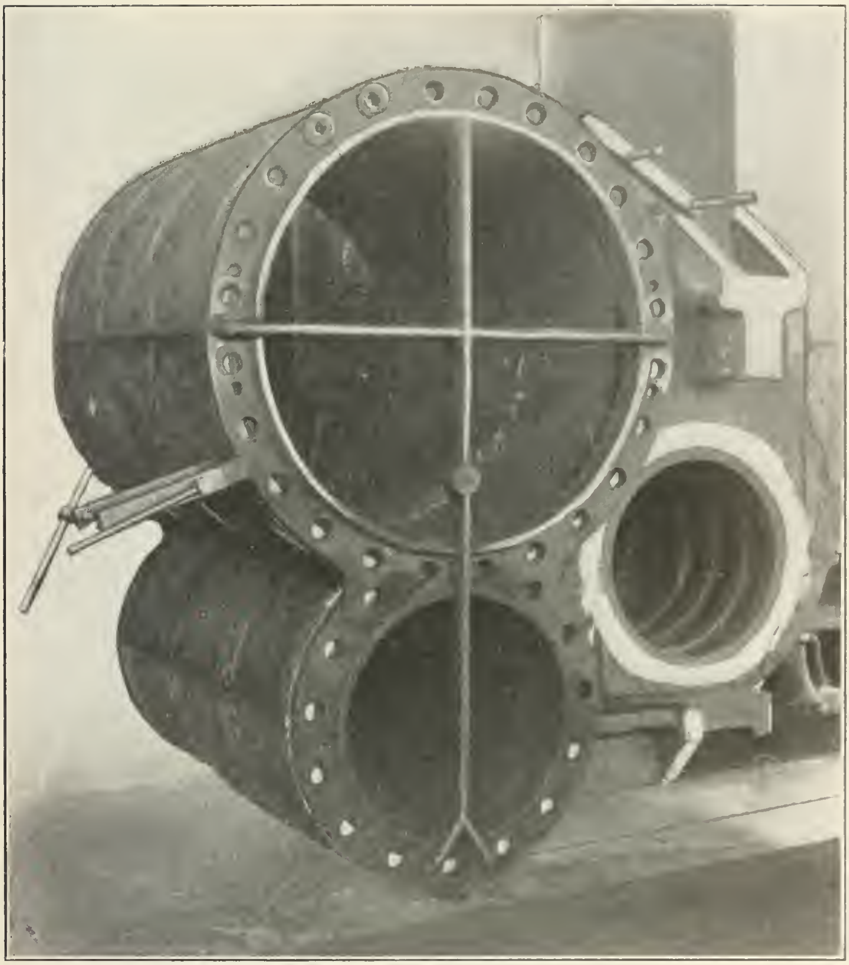
It would not pay, for instance, for a straight overland line say of 1,500 or 2,000 miles in length, with good facilities, foundries, etc., at each end of the line, to decide to manufacture all of the material at some point near the middle of the line, where no foundry or other needed equipment was located. I have in mind a certain railway, whose machine shop was located near its western terminal; its largest car shop was a little farther east, and it bought its wheels from a foundry at its extreme eastern terminal. With the idea of centralization of work in mind, the people in charge ordered all wheels for car work fitted up at the western end. This caused all new wheels to be hauled through the point where the car shop was located, and then hauled back after being mounted. It also caused all old wheels to be sent west to be stripped, and then hauled back the entire length of the line, as scrap. This haul in freight alone, at ½ cent per ton mile, cost $1,200 in a month, besides causing an extra delay of at least one day in delivery from the time the wheels left the foundry until the time when they were mounted and ready for the cars. Of course, the argument can be made that centralization was not at fault, but rather the location of the shop with reference to the base of supply. This is indeed true, and all this trouble could be avoided by relocating the shop; but this discussion is not intended to include the provision of new equipment; it is intended to confine the consideration to plans which will work with the present equipment of the road in question. There is not one railway in twenty now in a position to consider the rebuilding of all its shops, or even the relocation of its base of supply. We must deal with conditions as we find them.

A shop that turns out finished material, whether it be pilots or petticoats, is a manufacturing concern or establishment, and must be recognized as such. It requires no large array of figures to prove that the larger the output of a given article, the lower will be the labor cost per piece. If a man can turn out six brasses, for example, in one lot at a given rate, it stands to reason that he ought to turn out twenty at one time at a reduced rate per brass. This is true of any other article needed in railway work. The fewer the changes of tools and settings to make, the less the number of tools to keep up, and the more familiar the workman becomes with each particular class of work, the larger are the opportunities for the reduction of cost. Centralization of work allows for the full development of the specialist, which is the greatest factor in the labor end of production. With one main shop and a foundry in connection with it, the furnishing of material ready for service for all points comes in line as naturally as a wrapping department in a large mercantile house. There is an even and logical sequence of operations in the movement of the article from the foundry or furnace to its place of service. This method reduces the amount of stock to be carried, and consequently does away with all the expense of extra handling of stock, etc. It reduces the amount of tools, jigs, and machines required to get the stuff in shape for service. For instance, it requires a certain expensive machine, a set of jigs, angle plates, tool holders, etc., to prepare properly shoes and wedges, or driving boxes for use on an engine. If there are eighteen shops on the road where these are to be used, this calls for eighteen sets of tools, jigs, etc., for this particular article. With this job specialized and all done at one place, the chances are that one set of these tools, jigs, etc., would be sufficient to supply the entire equipment. Clearly, this would cut out seventeen no-longer-needed machines, sets of tools, angle plates, jigs, etc., besides the work and the men formerly required at each place, to fit up and keep them in good order. On one road where this was done, it has secured a reduction in the small item of maintenance of machinery and tools, of $180,000 per year.

The particular templet here illustrated saves hours of work in laying cylinders off for the stud and bolt holes and insures absolute accuracy and interchangeability, and if the cylinders are completely finished before sending out to a smaller shop, but the one templet is required.

A jig or tool in continuous action is a money saver, and there cannot be too many under these conditions. A jig or tool of any kind, lying idle, is so much " dead capital " or money lost. Take the basis of eighteen shops and eliminate seventeen sets of tools, plates, etc., for each special part of a car or locomotive, and the figures run away up into the thousands.

The illustration of knuckle-pin-hole reamers shows a case of a money-making tool. At the top of the pile (page 906) will be noted standard gauges. These are supplied to each shop and large roundhouse and a set of knuckle-pin reamers for the classes of engines dependent there. An engine comes in with a knuckle pin to be replaced; the hole is worn oblong; there are four of each nominal size of these reamers, varying from actual size to ⅛ inch above by thirty-seconds. The hole is bored out by the smallest reamer possible and standard

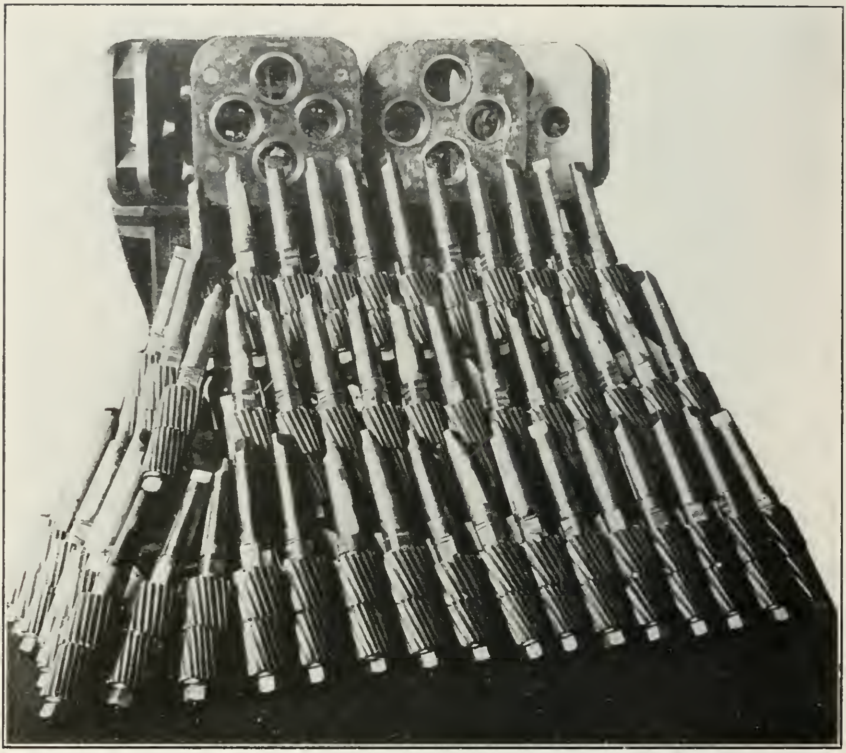


TEMPLET FOR USE IN DRILLING COMPOUND CYLINDER.

This saves hours of work in laying off cylinders for the stud and bolt holes, and insures absolute accuracy and interchangeability.

taper knuckle pins, completely finished and kept in stock, supplied from the general shop where centralized manufacturing is carried on, are applied. This process results in great economy of time in a roundhouse. The reamers are tried, frequently, by gauge, and when worn small are shipped in to the central tool-room for regrinding and resetting of the cutting edges.

The solution lies largely in the hands of the supply department—more there than in any other. The hearty co-operation of the me-



SET OF STANDARD KNUCKLE-PIN-HOLE REAMERS, MANUFACTURED TO WITHIN .003 OF SIZE IN THE CENTRALIZED TOOL ROOM.

At the top of this pile of reamers will be noted standard gauges. These are supplied to each shop and large round-house and a set of knuckle-pin reamers for the class of engines dependent there. When a knuckle pin needs to be replaced, the hole is worn oblong; there are four of each nominal size of these reamers varying from actual size to $\frac{1}{8}$-inch above by thirty-seconds. The hole is bored out by the smallest reamer possible, and standard taper knuckle pins, completely finished, and kept in stock, supplied from the general shop where centralized manufacturing is carried on, are applied. This process results in great economy of time in a round house. The reamers are tried, frequently, by gauge and when worn small are shipped in to the central tool room for regrinding and resetting of the cutting edges.

chanical department is an absolutely necessity, but the supply or store department should be the prime mover. It is the store department that should furnish accurate figures, annually, monthly, or on some periodical basis of consumption, as it is through this method only that the stock can be kept alive at all times. " Live " stock and its proper care, is fundamental to the entire railway-supply business.

The store should have absolute figures on engines and cars, according to class and location, with a full set of pattern books and forgings, planing-mill lists, etc., right up to date, at all times. Records of tire wear, journal wear, fire-box conditions, mill records, changes in design, new modern styles, etc., should always be easy of access to the supply department. Records of the distribution of power, changes in location, new rules on switching and terminal work of all kinds, should always be given to the store department. Stated reports, preferably quarterly, should be furnished by all master mechanics, showing just what engines or coaches will be shopped in the following sixty days, and then, with the tire-wear figures, journal-wear figures, etc., it is easy to decide on material needed. A close check should be kept by the store people on all engines and cars, according to the classes and length of time at certain locations. The consumption of cylinders, castings, timber, etc., at these given points in a given time, say two years, would give figures that would be accurate enough to work by. With all this work up and a monthly check of all engines, according to class, that are repaired at each point, it should be no trouble to keep plenty of material on hand, and still keep the stock at an extremely low figure.

A model material platform is shown on page 908. It will be noted that this material is what is known as "finished;" that is, the castings have been machined to size and are in almost every case ready to be applied to the engine on the erecting floor, thus saving delay of the engine in shop by awaiting the re-machining of the old part. This particular platform is storing material ready for shipment out on the road to smaller shops, but such finished material as is needed in the main shop is also drawn from this platform and transported by means of the shop tramway system, one of whose trucks is also shown.

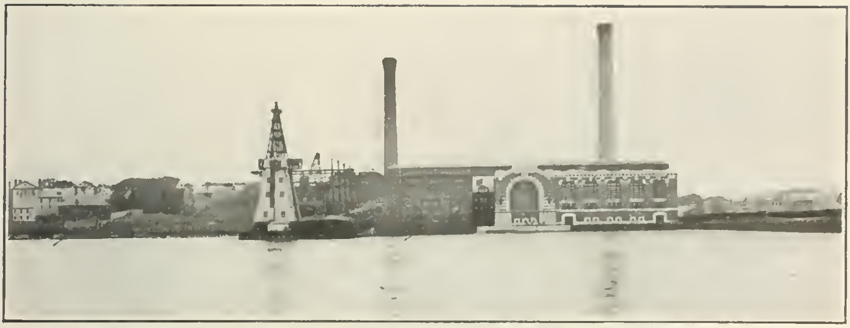
On ten engines of Class 1 type, for example, located at five points, showing a monthly consumption of two link-lifter bushings, it would be a simple matter to cut up twenty feet of tubing and send six bushings, or three-months supply to each point. If this is not done, the chances are that each shop will order a 10 or 16-foot length, and thus have over 100 feet tied up, whereas one-fifth of the stock would have done the business. This example could be carried out indefinitely, until it numbered up in the hundreds, for every point on the system and for each class of engine. Thus the store, by an accurate and careful system of record keeping, should have correct figures on consumption, and then put it up to the shop people to meet the demands. Let both departments get together and work hand-in-hand. Let the shop know what is expected, supply it with material, and require it to deliver the goods. Let the shop people devise

MODEL RAILROAD-SHOP MATERIAL PLATFORM.

This material is what is known as "finished"; that is, the castings have been machined to size and are in almost every case ready to be applied to the engine on the erecting floor thus saving delay of the engine in shop by awaiting the remachining of the old part. This particular platform is storing material ready for shipment out on the road to smaller shops, but such finished material as is needed in the main shop is also drawn from this platform and transported by means of the shop tramway system, one of whose trucks is also shown.

the ways and means and promulgate the methods; if the store supplies the figures and material they are doing their duty; it is then up to the shop people; where the stuff can be put up the cheapest; there is where it should be done. If pilots can be made at one place cheaper than anywhere else, let that point make the pilots; if piston rods can be got cheaper at the same place, let that point make all the piston rods for the system, and so on through the list. After the cheapest point has been settled upon for each article, should it be found to pay to transfer certain machinery to another point, do not hesitate to transfer it. Logs used to be hauled to the saw mills; now the saw mills are taken to the timber. Men are like machines—if it would pay to transfer them, do not hesitate to do it. Do not keep an 18-K man in a 2-K shop; if you cannot give him an 18-K shop take him to it. Give the best men the best facilities and the result will justify the move in every case.

If you get accurate figures, and have the stock properly handled, use the best methods and labor in each department, and have each department in the hands of a good man, and let his word be a law unto all—then the centralization of work cannot fail to be a true time winner.



THE BOSTON EDISON ELECTRIC ILLUMINATING COMPANY'S TURBINE STATION.
Showing coal-storage arrangements. By courtesy of J. E. Moultrop, Mechanical Engineer.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

By A. E. Dixon.

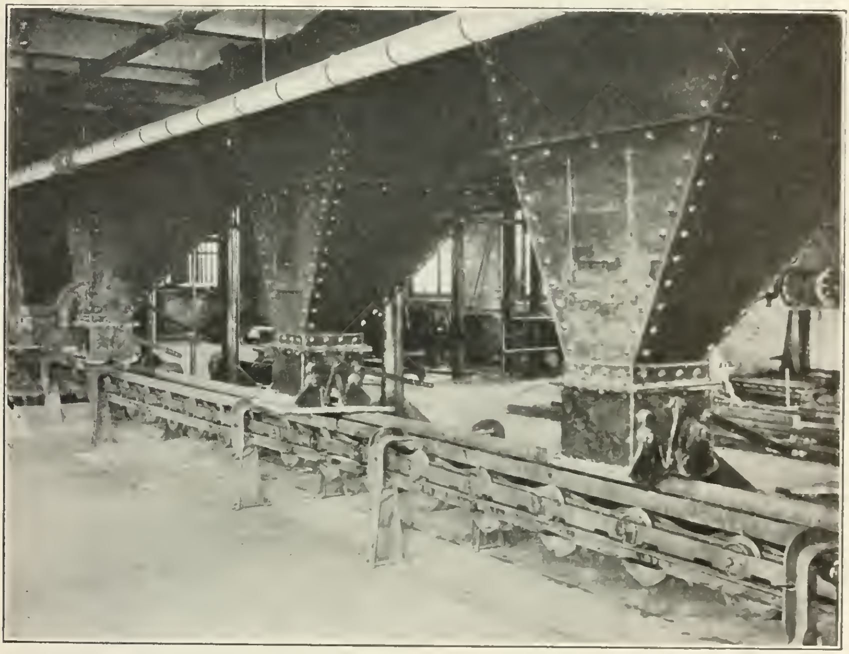
II. THE LOCATION, AND THE STORAGE AND HANDLING OF FUEL.

We pointed out in connection with Mr. Dixon's general introductory article last month that he wrote from the position of a man very much "on the inside" of all the questions arising in the design, building, and equipment of the power plant. His series will cover every important point on the physical side of the problem, and will offer much of value to all concerned in this department of constructive engineering. The next section, which will appear in October, will take up boilers, grates, stokers and chimneys.—The Editors.

A SUITABLE location for a power plant is often difficult to determine; it often depends upon the source of power to be developed, but there are other considerations. If a water power is used the location depends upon the point where the maximum hydraulic head with a suitable flow of water can be obtained at the lowest first cost, within the practicable radius of distribution. If gas or steam-driven prime movers are to be installed there is more liberty in the selection of a site, but it must be accessible, in regard to the fuel, water, and labor supply and the disposal of waste, etc.

The available local labor supply and the possibilities it offers in the line of skilled men, or the attractions which the neighborhood presents tending to make men contented with the locality, combined with the easy accessibility of the plant from residence districts suited to the various grades of employees, should all be considered. It is comparatively easy to bring men into any locality, but it will often take more than a steady job to hold them, except at times when business is so dull that it is next to impossible to secure situations in a more desirable neighborhood. Another point to be considered is that after men with families have located in the vicinity of an industry by which they are steadily employed, they are loath to change; and suburban locations, slightly out of the large centers of population, are desirable owing to the fact that labor troubles are not so liable to occur, and should they arise they can be handled better when located outside the lime light. This is particularly the case when considerable space is available around the industry on which temporary shelters can be erected. A desirable location where a permanent force of operatives can be had is an invisible asset of some value.

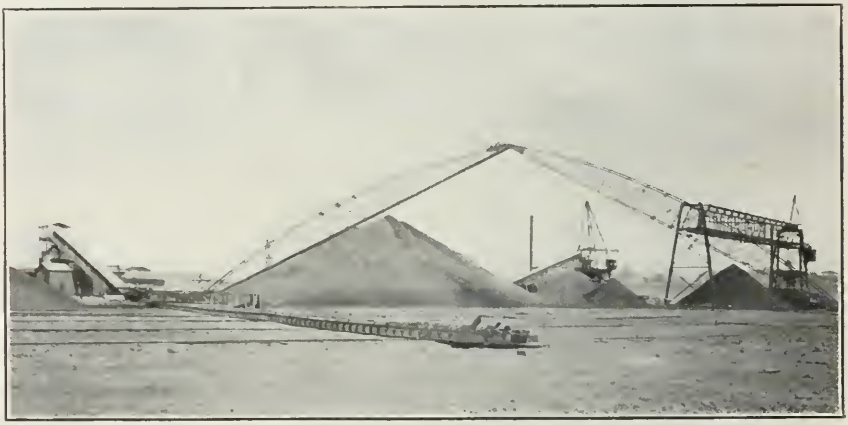
As to the water supply, considerable latitude is allowable, owing to the possibility of piping water from a distance. Good, pure water in sufficient quantities to cover all possible demands, is required, and the supply must not be subject to interruptions. Where city water is available, it is a good plan to make a connection for emergency purposes; but as such water must be purchased, it is in many cases, desirable for the plant to develop its own water supply. Where water is piped from a distance, it is advisable to provide storage tanks or a reservoir close to the plant, in order to guard against breaks in the line or the occasional unavoidable cutting off of the supply while repairs are being made, or for other purposes. The quantity of water required depends upon several considerations; the amount of boiler feed water depending upon whether surface or jet condensers are used, and in the former case whether the water of condensation is used or wasted; for circulating water for condensers, nearly any kind can be used with barometric condensers, but with surface condensers a strainer is important, and provision for cleaning it, salt or raw river water being used for this purpose. When the water supply is insufficient for circulating purposes, or the cost of water makes it advisable, a water-cooling plant can be installed, reducing the requirements for this purpose to an amount sufficient to make up the loss by evaporation. This plant can be placed on the roof of the building, if no other location is available, in which case the water will be pumped up from the sump and permitted to flow down through the cooler and tank and thence through the condenser by gravity. In many portions of the country, particularly in the limestone regions and around the American Great Lakes, it is almost impossible to obtain good water from natural sources for boiler feeding, and the boilers require constant attention and have to be blown off frequently and likewise shut down to have the scale chipped out. The modern method, and the most economical plan, of dealing with feed water of this character is to remove the scale-forming substances before they reach the boiler; and while numerous plants for purifying feed water have been installed throughout the middle western States, and have proven their efficiency in actual operation, reducing fuel consumption and the expense of boiler cleaning and repairs, it is nevertheless remarkable that comparatively few of these plants are operated by concerns generating electric power.



A SYSTEM PROVIDING FOR MECHANICAL HANDLING OF BOTH COAL AND ASHES.
PRATT STREET STATION, UNITED ELECTRIC RAILWAYS, BALTIMORE.

The ash hopper and cut-off valves above the bucket conveyor show plainly in the picture. The coal in this plant is hoisted by a steeple tower and carried to storage bins on an automatic railway. The C. W. Hunt Co.

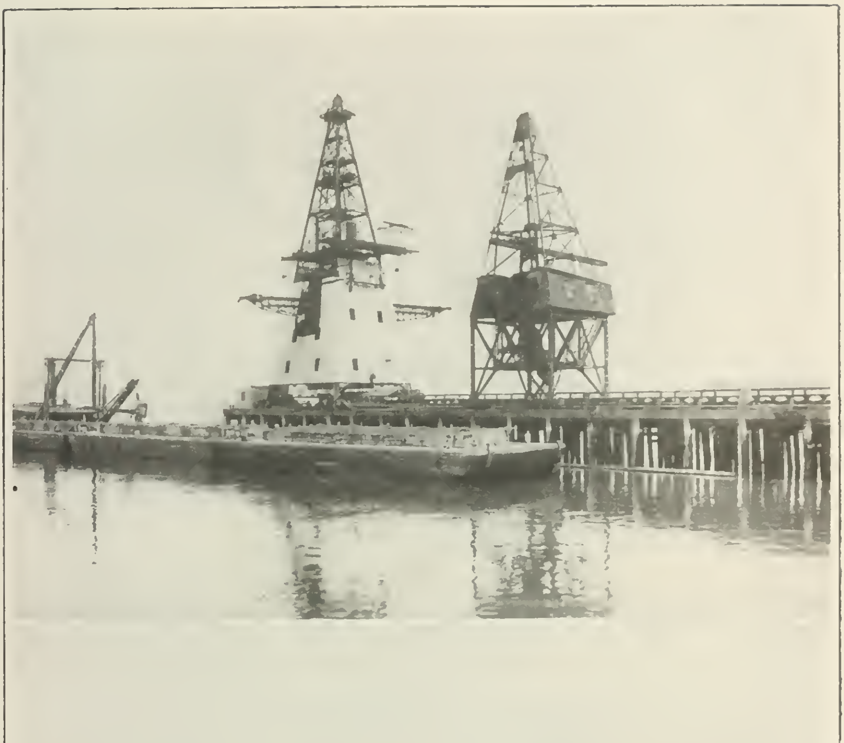
The fuel question—or more exactly, the method by which fuel can be delivered—is of the highest importance. The cost of fuel is not the price entered on the bill, but properly includes all the expense of handling it between the cars and the fire-box, plus the expense of removing and disposing of a proportionate amount of ashes. As the amount of coal required is from ten to twenty times the weight of the ashes, it can be seen that it would be cheaper to cart ashes than it would be to cart the coal; in other words, it is more important to be close to the railroad or water way, so that coal can reach the plant in cars or barges, than it is to be close to the dump where the ashes can be disposed of. In any event, the cartage of either ashes or coal should be avoided, and the less handling there is between the mine and the ash pile the cheaper the fuel. The importance of looking out for this matter has often been neglected—particularly in some plants which, originally small, have been extended from time to time, until the troubles incident on carting the coal supply (as well as the expense) have forced the construction of a new plant in a more convenient location, and handicapped the concern with a dead investment in brick and mortar.



GENERAL VIEW OF THE NEW YORK EDISON COMPANY'S COAL-STORAGE PLANT, SHADYSIDE, N. J.

Shows part of the anthracite storage, the hoisting tower for anthracite, and the bridge tramway for bituminous coal. Dodge Coal Storage Co., Phila., Pa.

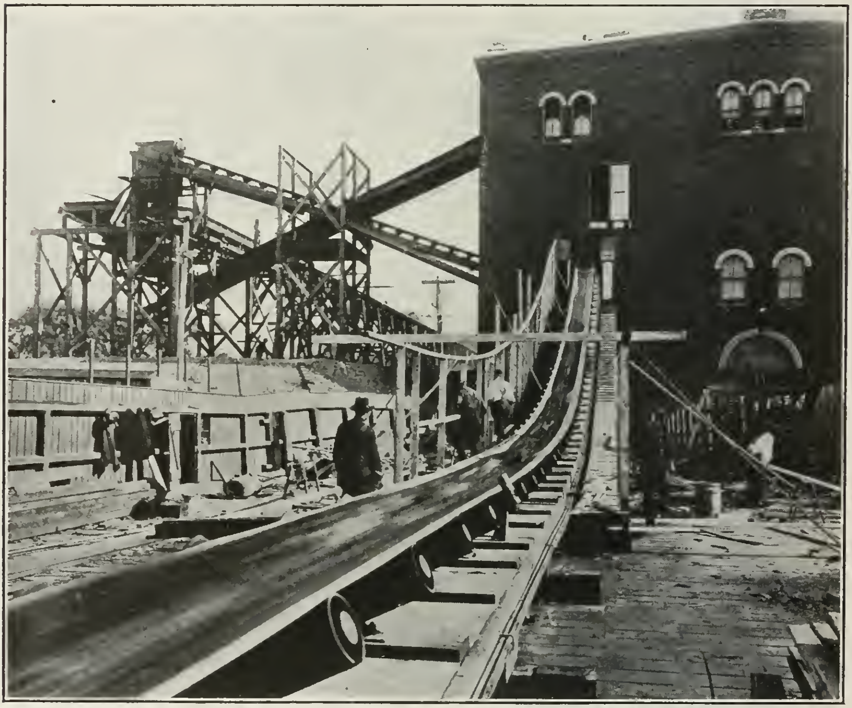
As plants increase in size, the importance of a reserve supply of coal as an insurance against interruptions in the service makes itself evident; small plants often run several days on a car of coal, but there are plants where this quantity would not suffice for one hour. Water transportation is, in many localities, closed for several months in the year, and where it remains open is greatly hindered by floe ice, and it may take several days or a week to place a barge, which under ordinary conditions could be delivered in half a day. The moral of this is, in selecting a waterway choose one where the ice will be swept out by natural currents. Railroads are subject to interruptions from wrecks, storms, and floods, and on several occasions, in the United States during the last few years, have been so badly clogged up with freight that it has been impossible to tell how long a car or train would be on the road. In fact, in some localities an embargo was placed on all except perishable freight, and even the largest industries had trouble in getting fuel enough to keep them going, even when men were sent out to trace cars in. Strikes in the coal regions are liable



COAL HANDLING AND STORAGE AT THE BOSTON EDISON ELECTRIC ILLUMINATING COMPANY'S TURBINE STATION.

The hydraulic tower is designed and installed by the Robins Conveying Belt Co. The bridge, grab bucket and transporter in the lower view are by the Brown Hoisting Machinery Co. The pictures are shown by courtesy of J. E. Moultrop, Mechanical Engineer.

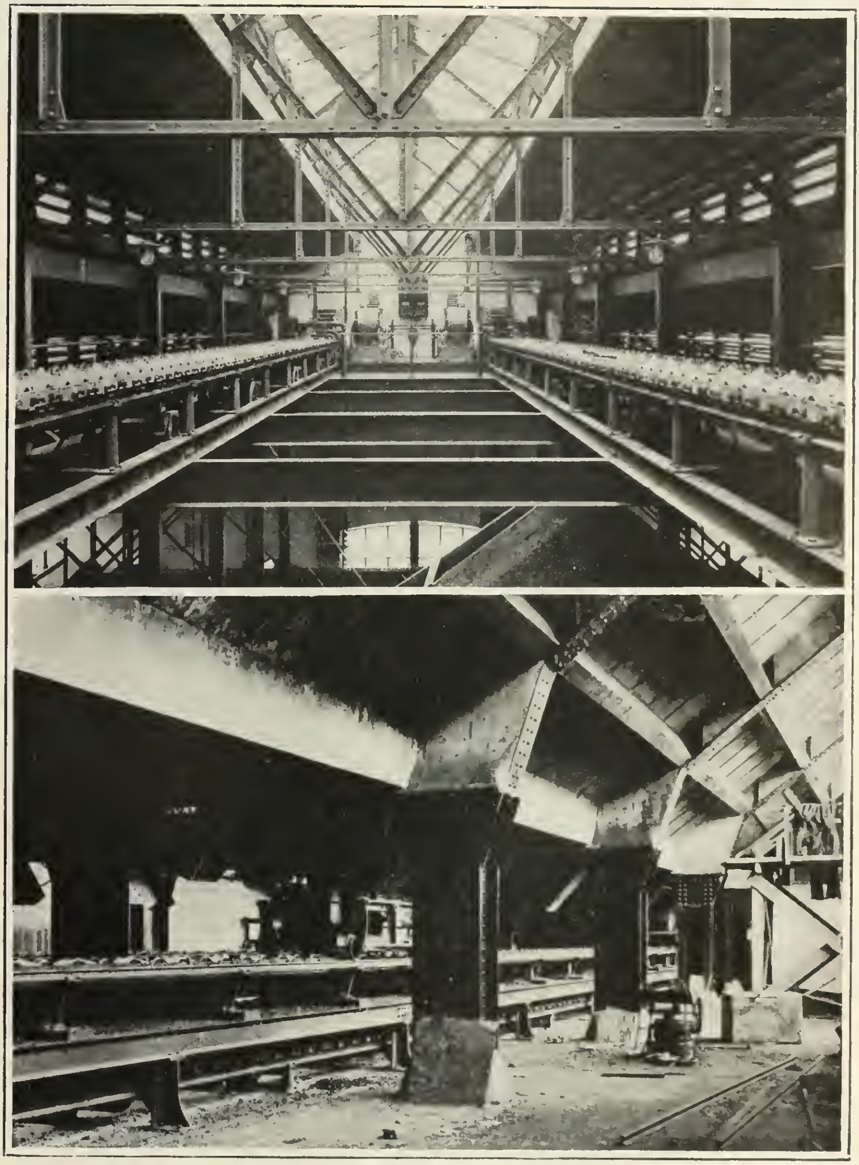
to occur at almost any time (agreements to the contrary notwithstanding) during which production may be stopped for an indefinite period; during and immediately preceding a strike, it is the practice of the railroads to seize all the coal they dare, which is on their tracks, for their own use; and while such coal is ultimately paid for, coal at such a time is the most precious jewel of the power plant. In certain portions of the United States natural gas is available, and can be used under the boilers or in gas engines; of such fuel a reserve is not kept, though often duplicate pipe lines are installed between the wells and the power house. In other localities, oil fuel can be used with advantage, being delivered to the plant by cars, boats, or pipe lines; a storage tank for the current supply is provided close to the plant, the amount of tankage provided being dependent upon the quantity of oil received as a shipment and the fuel consumption of the plant; the regularity of the shipments must also be considered.



THE COAL CONVEYOR, BOSTON EDISON ELECTRIC COMPANY'S TURBINE STATION.

Robins Belt Conveying Co. By courtesy of J. E. Moultrop, Mechanical Engineer.

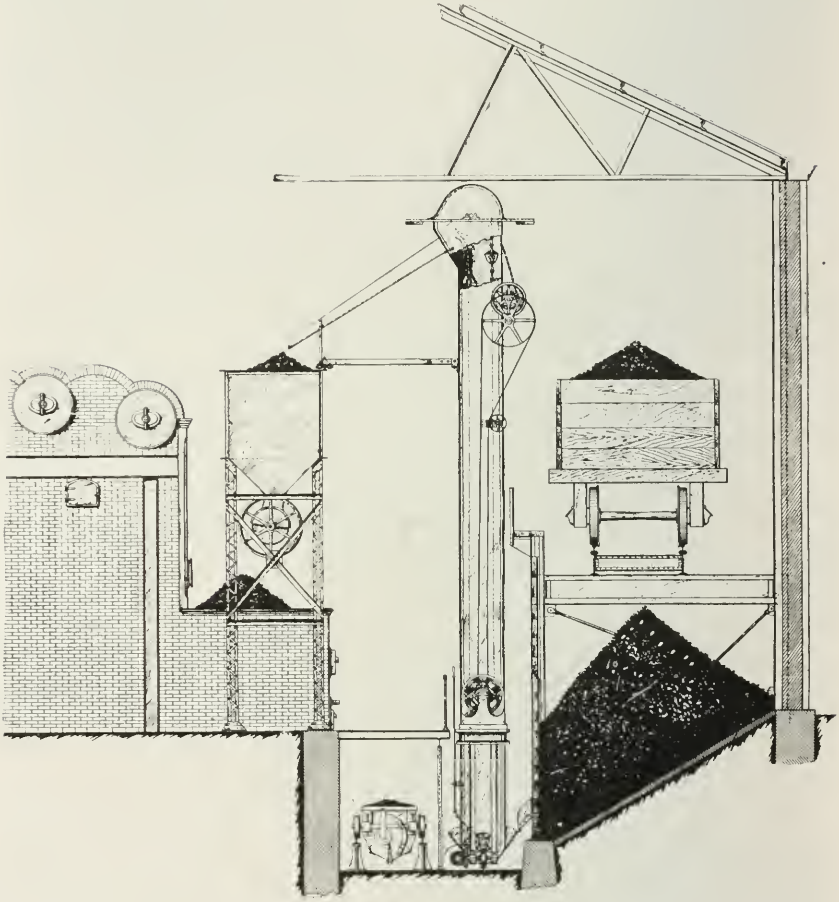
The fuel-storage plant should be, preferably, located by the side of the generating station in order that the amount of plant required will be reduced to a minimum. It is also desirable to provide some



COAL-HANDLING CONVEYORS AT THE NEW POWER STATION OF THE LONDON COUNTY COUNCIL, GREENWICH.

Two combined conveying and elevating strands, buckets pivot-hung on double-strand chain. They receive coal from overhead storage hoppers, outside, through fillers shown in the lower picture; entering the building by a horizontal run of 100 feet, they rise 90 feet to the driving gear seen at the back of the upper view. This consists of two 25-horse-power motors, direct coupled to end shafts of conveyors by cut steel gearing. Thence the strands run horizontally 300 feet, delivering coal to boiler hoppers as seen in the top view. Then dropping to the basement they pass by below the boilers, receiving ashes and dumping them direct to barges outside. This lower strand may be seen in the bottom picture. New Conveyor Co., Ltd., Smethwick.

bunker or hopper capacity over the boilers, in order to guard against conveyor breakdowns.

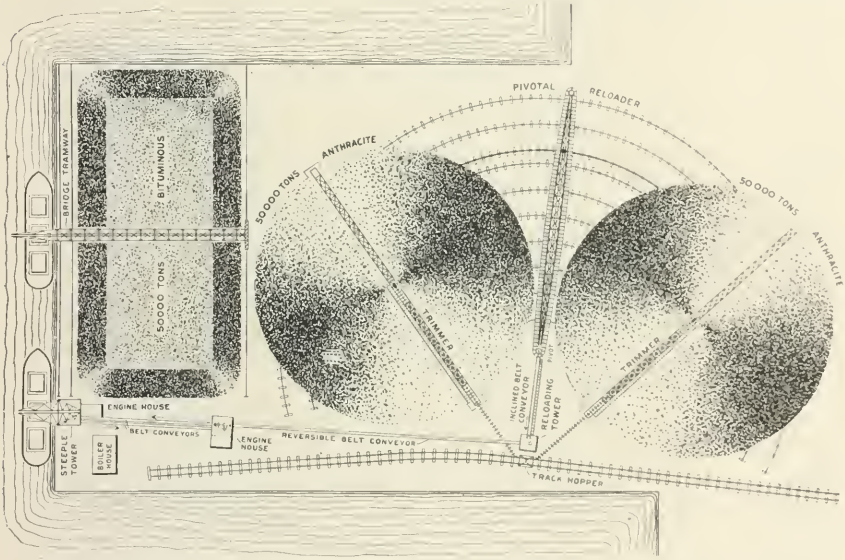


GENERAL PLAN OF COAL HANDLING AT THE UNITED TRACTION COMPANY'S POWER HOUSE, ALLEGHENY, PA.

Heyl & Patterson, Pittsburg, Pa.

A fuel-storage plant of any size involves a considerable investment in its equipment, and to this must be added the amount of capital locked up in the coal stored; the interest on this amount, together with the cost of operation and upkeep add to the fuel expense of the plant. To offset this, it is impossible, except in rare cases, to control the fuel supply from the mines and the services of the transportation medium; therefore it is necessary for the large consumer whose continuity of operation is entirely dependent upon the daily delivery of several hundreds of tons of coal to adopt measures which will efficiently protect his interests during all emergencies. This can be done only by providing a storage plant of sufficient capacity. A ton of coal at the plant is worth several under contract, for while the contract may provide all sorts of penalties in the line of liquidated damages from failure to deliver, the collection of these sums is slight salve for the black eye given the power plant by reason of an enforced shut down from lack of fuel.

As an instance of provisions of this nature, it may be stated there are several industries in the United States which carry a coal supply under their own control of from 50,000 to 250,000 tons, to guard against fuel shortage. For several years the Carnegie Steel Company had a coke pile at the Edgar Thomson Works, which was 2,000 feet in length and 60 feet high. This pile was started at a time when labor trouble in the coke region was imminent, and the pile was left for several years as an object lesson. The pile was ultimately removed, when owing to a locomotive famine, it was impossible to get coke shipments through, and as a result the Carnegie furnaces were kept in full blast when many of the competitors had to bank or shut down their furnaces.



GENERAL PLAN OF COAL STORAGE AT THE PLANT OF THE NEW YORK EDISON CO., SHADYSIDE, N. J.

Installed by the Dodge Coal Storage Co., Phila., Pa. Provides for a reserve supply of 100,000 tons anthracite and 50,000 tons bituminous

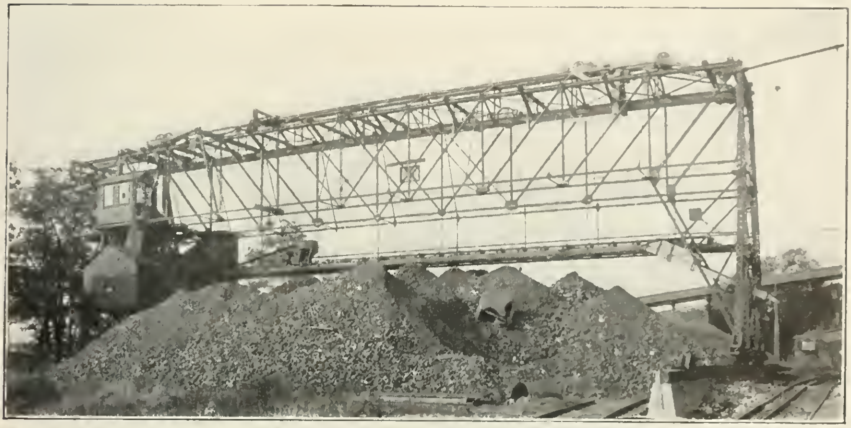
Coal is best stored under cover, but either under cover or in the open—in fact, from the time it is first exposed in the breast at the mine—all coals, bituminous and semi-bituminous in particular, are losing in heating value, a constant chemical change being in progress by which gas is being liberated. In warm weather or in hot climates this deterioration is more rapid than at low temperatures. These gases are frequently several times the volume of the coal, being occluded or condensed within the solid substance, until by diffusion they escape and are lost in the air. This subject has been investigated by Dr. Lyon Playfair, in England, and Dr. E. von Meyer, in Germany, and the following figures are extracted from a report by the latter, showing the quantity and composition of the occluded gases in freshly mined samples of coal submitted to him. The method adopted to determine the amount of the gases was to place 100 grammes of the coal in hot de-aerated water, which was then boiled as long as any gas continued to be given off, the gas being collected and then analyzed by Bunsen's method.

Sample	Percentage by Volume.				Cubic centimetres of gas given off from 100 grammes of coal
	CO_2	CH_4	O	N	
1	16.51	trace	5.65	77.84	24.4
2	0.34	85.80	trace	13.86	91.2
3	1.15	84.04	0.19	14.62	238.0
4	0.23	89.61	0.55	9.61	211 2

All the above were English bituminous coal, the first being a Newcastle coal and the others from different seams in the same colliery in Durham. The second and third samples, while from different mines, were from the same seam. The depth below the surface from which these coals were raised was as follows: No. 1, 180 feet; No. 2, 445 feet; No. 3, 650 feet; No. 4, 890 feet. It will be noted that CH_4, or marsh gas, formed an important portion of the volume of gases given off by the latter three samples. This gas has a high thermal value. The same losses affect anthracite coal, but only to a slight degree. Oxidation or slow burning of the coal also occurs, and it not only loses in weight but in heating values. In one instance the decrease in weight observed in some stored coal was over 35 per cent, after a lapse of some years.

For the generation of steam power, bituminous or semi-bituminous coals are widely used; the smaller sizes of anthracites are also burnt in many plants, but for these latter coals a high chimney or forced draft is required.

All coal contains some moisture, and when exposed to the weather it increases its moisture content. The bituminous coals seem to undergo a slacking process, the size of the lumps being reduced and



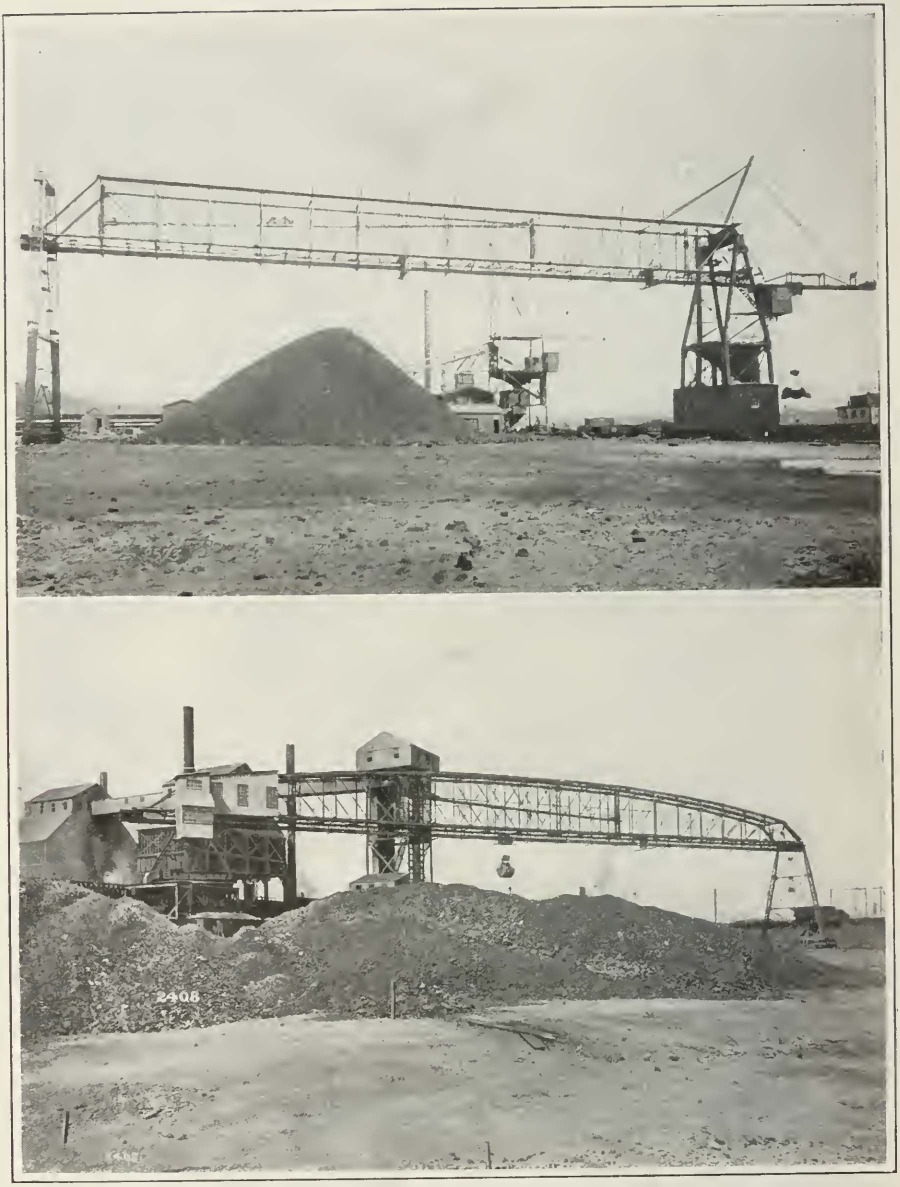
FLYING BRIDGE, AMERICAN TUBE & STAMPING COMPANY'S BILLET MILL, BRIDGEPORT, CONN.

Robins Conveying Belt Co.

the percentage of dust being greatly increased. In winter the contained water freezes and breaks up the lump coal.

Coal is usually shipped from the mines in hopper-bottom or high-sided gondola cars, which are open to the weather; as a result, in winter, shipments often arrive frozen solid in the car. Such coal is rather difficult to handle; explosives cannot be used in wooden cars, and unless considerable care is employed will damage steel cars; this makes it necessary to thaw out the coal. For this purpose steam lines should be run along the tracks on which the cars are handled, provided with steam-hose outlets at car-length intervals. Steel hopper cars are thawed by inserting the nozzle through the hopper in the bottom, the coal as released falling into the track hopper, but for gondolas this operation is troublesome. The steam pipe, along the track, should be very well protected from the frost, owing to the fact that condensed steam which accumulates in it in the intervals of disuse freezes very easily.

Outdoor stock piles, during cold weather, accumulate a frozen crust which is often so thick that grab buckets cannot penetrate it. Explosives furnish the easiest method of dealing with this difficulty, but it will be found usually that considerable labor will be required to break up the large pieces to sizes that can be handled by the conveyors and crushers. To deal with such pieces, and also to warm up the conveyors and bearings previous to operation, steam-hose outlets along the runways and at the machines can be provided. A judicious use of a little steam on the conveyor bearings, after a cold snap, will make the machinery a great deal easier to start.



TYPICAL EXAMPLES OF LARGE COAL-STORAGE INSTALLATIONS.

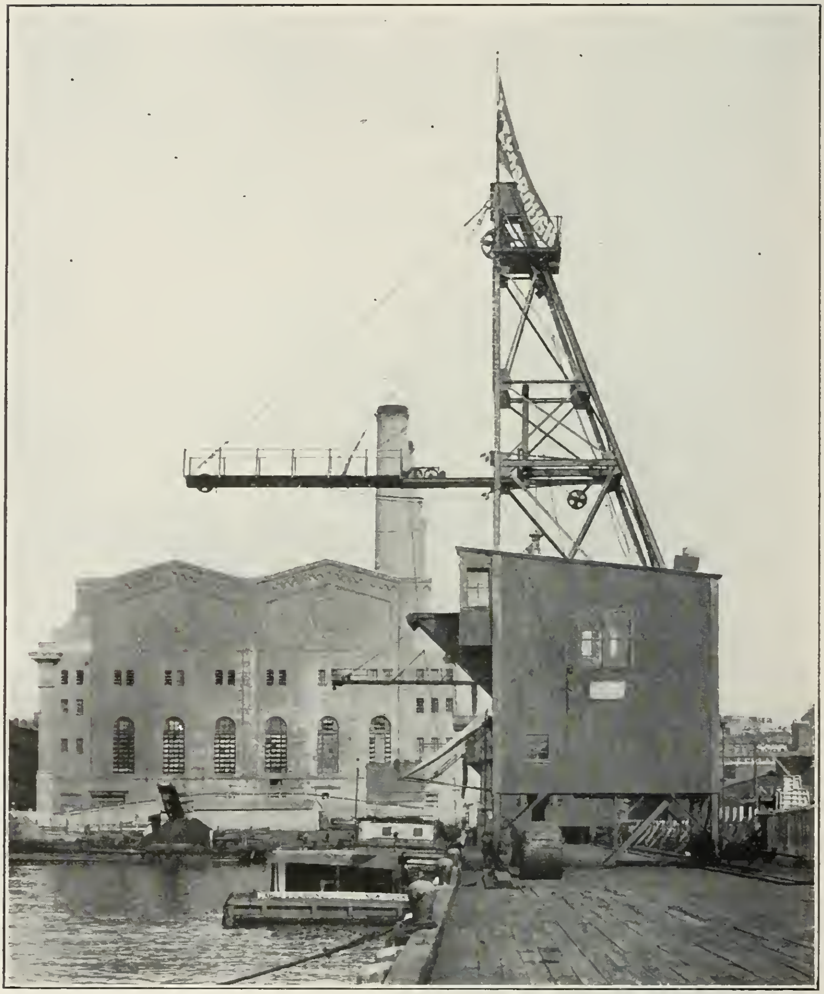
The lower one is at the Sparrow's Point plant of the Maryland Steel Co., commanding a storage of 50,000 tons bituminous by a 280-foot span steam-operated bridge tramway. The upper one is at the Shadyside plant of the New York Edison Co., steam-operated over a 200-foot span, with a 2-ton clamshell bucket, giving a storage of 50,000 tons run-of-mine bituminous. Dodge Coal Storage Co., Phila., Pa.

Another trouble with stored coal is its heating and igniting spontaneously. Any bituminous coal of a friable nature, and particularly those containing "brasses" or iron pyrites (FeS_2), are liable to this trouble; when the coal is stored in a damp condition the trouble is aggravated. The cause of such fires is obscure, but they probably arise from the absorption of oxygen by the carbonaceous matter of the coal, in the same manner as oily cotton waste ignites from the same cause. In many plants the bunker construction is well designed to contribute to the starting of such fires, the entire boiler room being covered and no outlets being provided along side of the bunker to permit the hot air arising from the boilers to escape.

These fires start at or about the bottom of the pile and may burn undiscovered for a considerable time. The indications of such a fire are a sensible rise in the temperature of the stored coal, a sickly odor, and a choking or smothering sensation in drawing breath when on that portion of the pile. Water is almost useless in fighting a fire of this kind, as the heat partially cokes the surrounding coal, forming a roof which prevents water reaching the fire in sufficient quantity to do any good, or the water will be turned into steam before reaching the fire. Sometimes it is possible to drive pipes, with pointed ends in which a number of holes have been drilled, through the coal to the seat of the fire, and by this means water or steam can be used with advantage; but to be absolutely sure it is necessary to move the coal and uncover the seat of the trouble. In bunkers this is a very necessary precaution, as the pasty coke formed by the fire will stick to the concrete or steel and furnish a dead spot as a nucleus for another fire.

There is considerable conflict of opinion in regard to the best method of preventing such fires, ventilation being recommended; should this method be adopted the ventilation should be thorough, for sluggish ventilation will not reduce the temperature of the pile, but on the contrary may tend to increase the trouble greatly. Fires of this kind are very common, but are usually discovered before they have made much progress. In large exposed piles there is less chance of their being caught at an early stage, and only a few years ago a fire of this kind burned for several months in a large pile, being finally discovered, because on this portion of the pile the snow melted as fast as it fell, while the remainder was deeply covered. This fire was a costly one, as several thousand tons of coal were consumed and considerable expense was incurred in extinguishing it.

The general arrangement and the plant required for coal storage depend largely upon local conditions. Most of the firms building this



COAL UNLOADING TOWER AT THE INTERBOROUGH RAPID TRANSIT COMPANY'S 59TH ST. POWER HOUSE, N. Y.

Installed 1906 by Mead-Morrison Mfg. Co., N. Y.

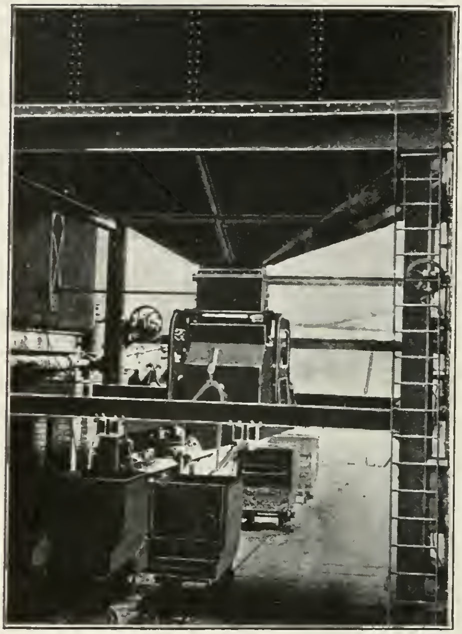
class of machinery are prepared to submit designs for plants of any desired storage and handling capacity, when they are furnished with ground plans of the area to be covered, and its contour. Some machines require level ground or else expensive grading to level up the area. Other machines require a runway track to be levelled up, the portion of the ground to be covered with coal being left in its natural condition, provided it is sufficiently firm for the purpose, or if the bridge be equipped with a suitable bucket, it can be utilized to do all of the grading necessary.

The character of the plant will depend, in part, upon the method by which the coal is received and sent out. In some cases coal is received only by boats, in others by cars alone, while in some plants it is desirable to arrange to receive or ship by both methods. As a general proposition, a traveling bridge supplied with a conveyor for stocking the coal and a bucket for getting it out, will be the most feasible method for large piles, for the reason that indefinite longitudinal expansion can occur; such expansion is not possible with circular piles. A bridge also has the advantage of being able to reach any part of the pile at any time; this may be very valuable should a fire occur. Bituminous coal should not be piled higher than thirty feet, and preferably lower.

When the plant is close to the power house conveyors can be used for transferring the coal to the bunkers, and this is the usual arrangement; but where real estate is expensive, it may be desirable to locate the storage plant at a distance from the power plant, and ship the coal in as desired by cars or in barges, as is done by the New York Edison Company. This latter is, however, a forced arrangement to suit exceptional local conditions, and has too many disadvantages to be even considered, except in a parallel case.

BOILER HOUSE OF THE SCOTTISH CO-OPERATIVE WHOLESALE SOCIETY, GOVAN.

The elevator carries coal over the main railway line, 30 tons per hour, 00 ft per minute, and discharges into a conveyor. It has 14-inch roller buckets. Blake, Barclay & Co., Greenock.



A PLANT FOR STORING COAL AND WEIGHING IT TO THE BOILERS.

Graham, Morton & Co. Ltd., (Maurice Graham), Leeds.

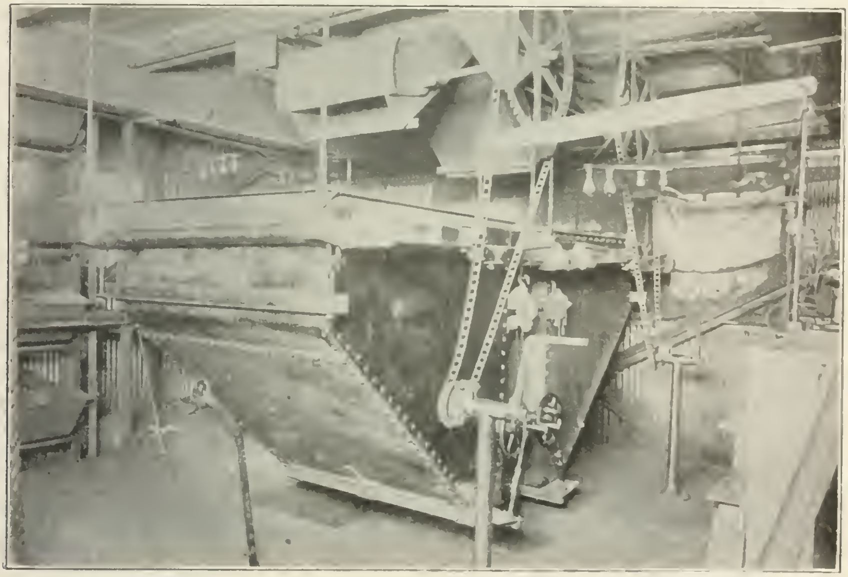
The coal-handling arrangement at the power house depends upon many considerations, being effected by the arrangement of the boiler plant and the location of the chimneys. In plants of any size mechanical stokers are generally employed to reduce the fireroom force, and it is desirable, even with hand firing, to chute coal down from overhead in preference to having it shoveled into cars or wheel-barrows, brought in by laborers, and either dumped in front of the boiler or shoveled from the car on to the grate. This latter practice is a favorite one at small hand-fired plants, the car or barrow often being run over a scale on its way to the boiler, and the weight of the coal and the boiler it is destined for being recorded. In plants having the boilers arranged in two rows with a common firing aisle, in some cases as many as three decks being used, the coal is of necessity brought down from above. The bunker capacity provided is determined by the location of the plant, but usually sufficient storage is provided to run from one to two weeks. This heavy bunker over the boilers of necessity makes the steel frame of the building very expensive, and is undesirable if any other method of storing the coal can be provided. If outside stock piles can be used, it is necessary to provide only sufficient storage capacity, over the boiler, to tide over conveyor break downs, and to act as a reservoir from which the stoker hoppers can be filled.

In some few boiler-houses weighing machines have been installed, by which the amount of coal consumed by each boiler can be determined. In other cases an attempt is made to keep track of the amount of coal burned by using the chute as a measuring hopper, the weight of coal which it will contain being determined by experiment; this method, however, is somewhat crude and uncertain. It is hardly necessary to say that some record of each boiler's performance is desirable

—in fact, is absolutely necessary for intelligent management, and such data cannot be secured unless the coal and ashes of each boiler are weighed with commercial accuracy. The day of guess-work boiler management in the power plant departed a number of years ago in some lines of work, and it is going fast everywhere.

The chutes or spouts by which the coal passes down from the bunkers should be designed to avoid blocking up. Coal, like sand, has a tendency to form arches between the walls of the pipe, which have to be poked out from time to time. Round pipes are worse in this respect than square ones, and the larger the pipe the less chance of its blocking; but there are limits to the size, therefore "Y" outlets should be provided at each floor in the pipes which pass through it, to permit poking out the pipe when the necessity arises.

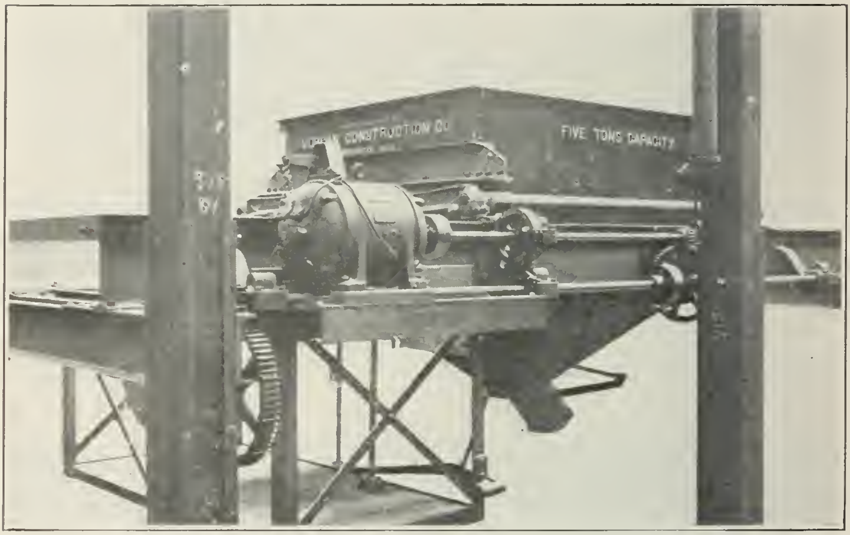
The amount of overhead bunker capacity varies with the layout of the boiler house; in some cases the stacks are at the sides of the building and the bunker is continuous the full length of the building, but when the stacks are mounted on platforms over the firing aisles the bunker capacity is reduced by the amount of space taken up in this manner, and it is also necessary to install two distributing conveyors in order to trim the bunkers automatically; in fact, unless the bunker is very narrow or the surcharged height of the coal pile above it



DOUBLE WEIGHING HOPPERS FOR COAL, POWER PLANT OF THE INTERBOROUGH RAPID TRANSIT CO., 74TH ST., N. Y.

The coal is fed to McCaslin conveyors. Installed by John A. Mead Mfg. Co., N. Y.

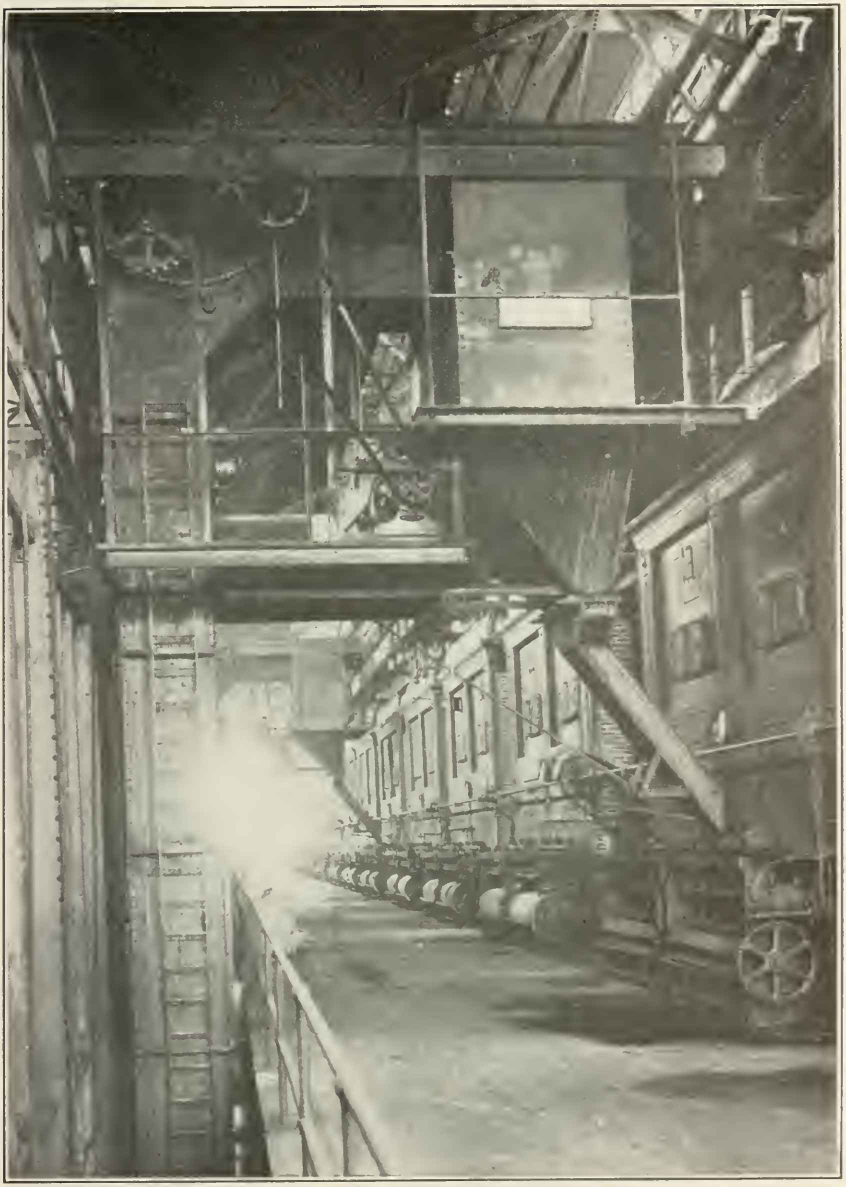
greatly exceeds that permissible in regular practice, two conveyors, one on each side of the center and about one-sixth of the width of the bunker from it, will reduce considerably the amount of hand trimming required. It is impossible to avoid hand trimming entirely, and occasions will arise on which men will have to be sent into the bunkers —to uncover a fire, for instance; to provide for this contingency permanent ladders reaching to the bottom of the bunkers should be built into its lining, at convenient intervals.



CRANE TYPE TRAVELING COAL ELEVATORS, UNION STEEL COMPANY'S BOILER HOUSE.

Installed in connection with Sterling boilers and chain grate stokers by Heyl & Patterson, Pittsburg, Pa.

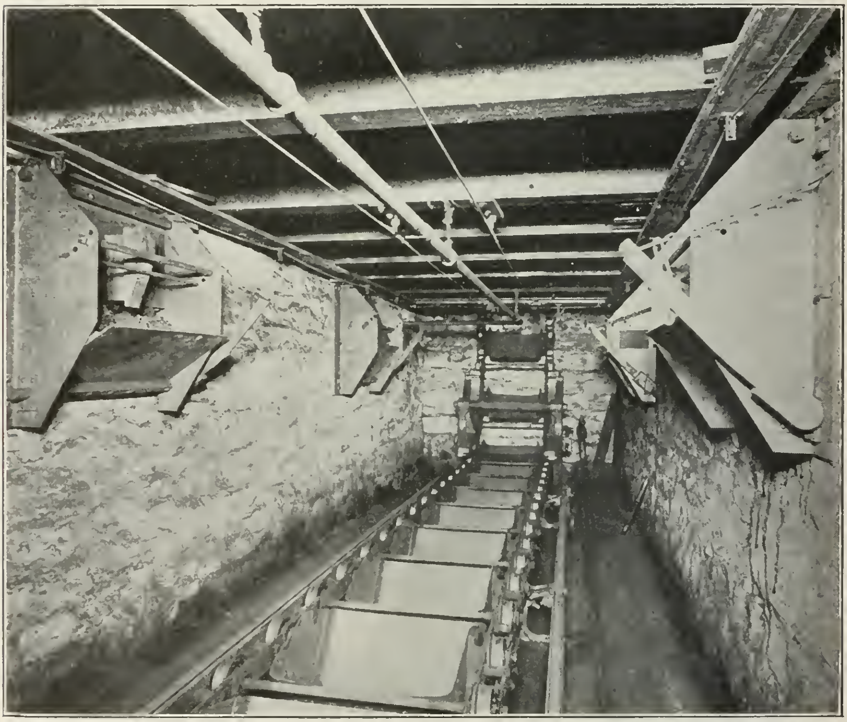
In long buildings it is desirable to reduce the length of the bunker distributing conveyors; this can be done by locating the elevators near the center of the plant, or when local conditions forbid such an arrangement, by sectionalizing the longitudinal conveyor. With this latter arrangement the capacities of the different sections can be proportioned to the amount of coal they are required to handle. In the Long Island City plant of the Pennsylvania, New York and Long Island Railroad, there is no conveyor, a cable railway being used to distribute the coal; while in the Cedar Avenue power house of the Cleveland Electric Railway, coal cars of 50-tons capacity are elevated to a track running over the bunker; these cars when loaded have a gross weight of approximately 140,000 pounds, necessitating very substantial construction of the apparatus and building. In this latter case the unloaded cars can be lowered to the basement and run in under the boilers to receive ashes from the hoppers built for this purpose. The plan is shown on page 933.



ELECTRIC CHARGING CRANE WITH WEIGHING HOPPER.

Morgan Construction Co., Worcester, Mass.

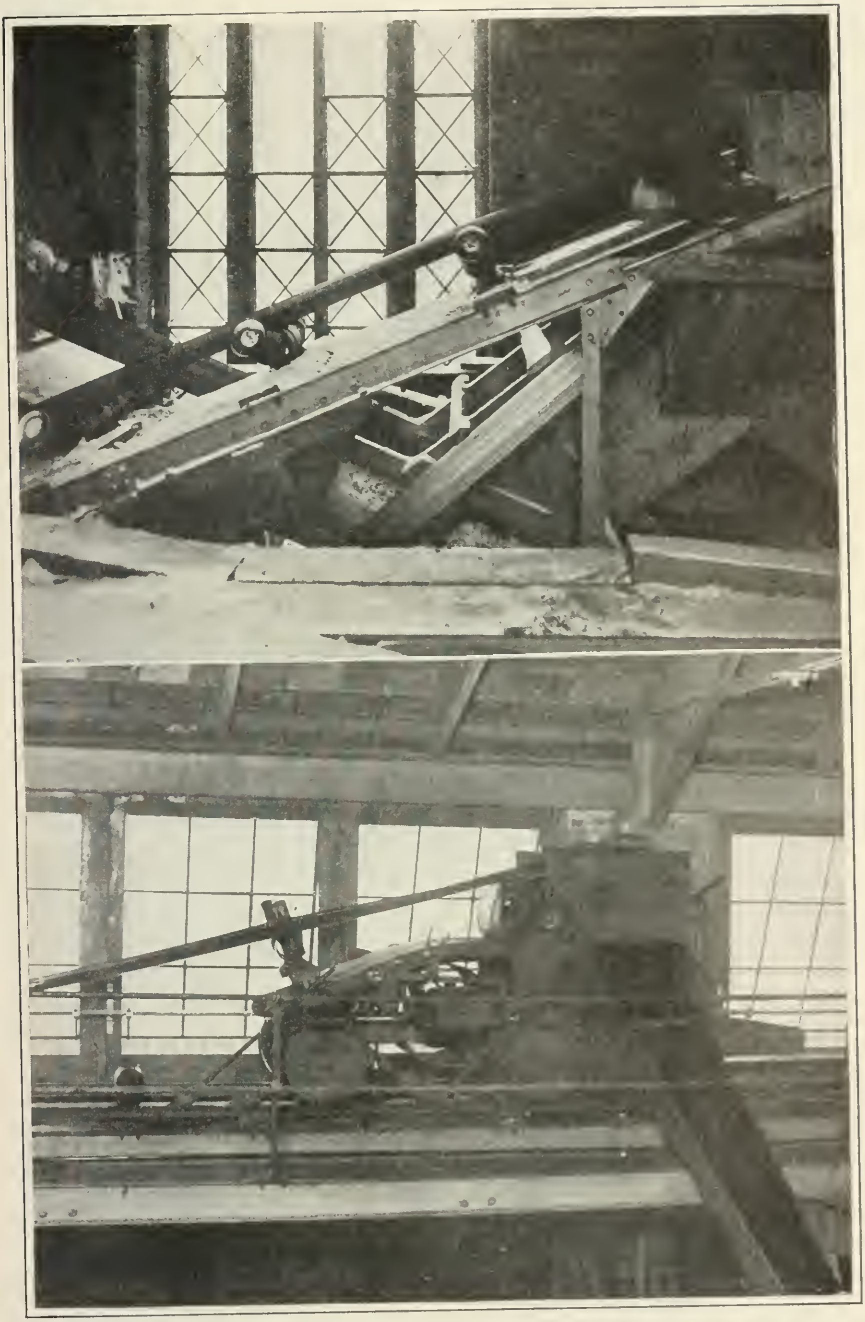
The conveyor layout should be kept in mind from the beginning, as it is necessary to allow room for the conveyor runs and for the walkways which parallel them. The conveyor runs should be as short and direct as possible and corners or turns should be avoided. As far as possible, horizontal and vertical runs should be used; inclined runs are undesirable with bucket or scraper conveyors, and except for slopes of less than 22½ degrees are impracticable for belt. Scraper conveyors waste a great deal of power, owing to the friction of the coal against the bottom of the trough. Bucket conveyors are more economical of power on the horizontal runs, and are the only type which is available for vertical lifts. Belt conveyors are the most economical, in regard to power, for horizontal and slightly inclined runs. In a few cases belts have been used to elevate material to considerable heights, a series of inclined conveyors being used when the height was too great to be reached by one belt on a straight run.



A COAL HANDLING CONVEYOR IN A TUNNEL, WITH DOUBLE-FLAP FEEDING VALVES.

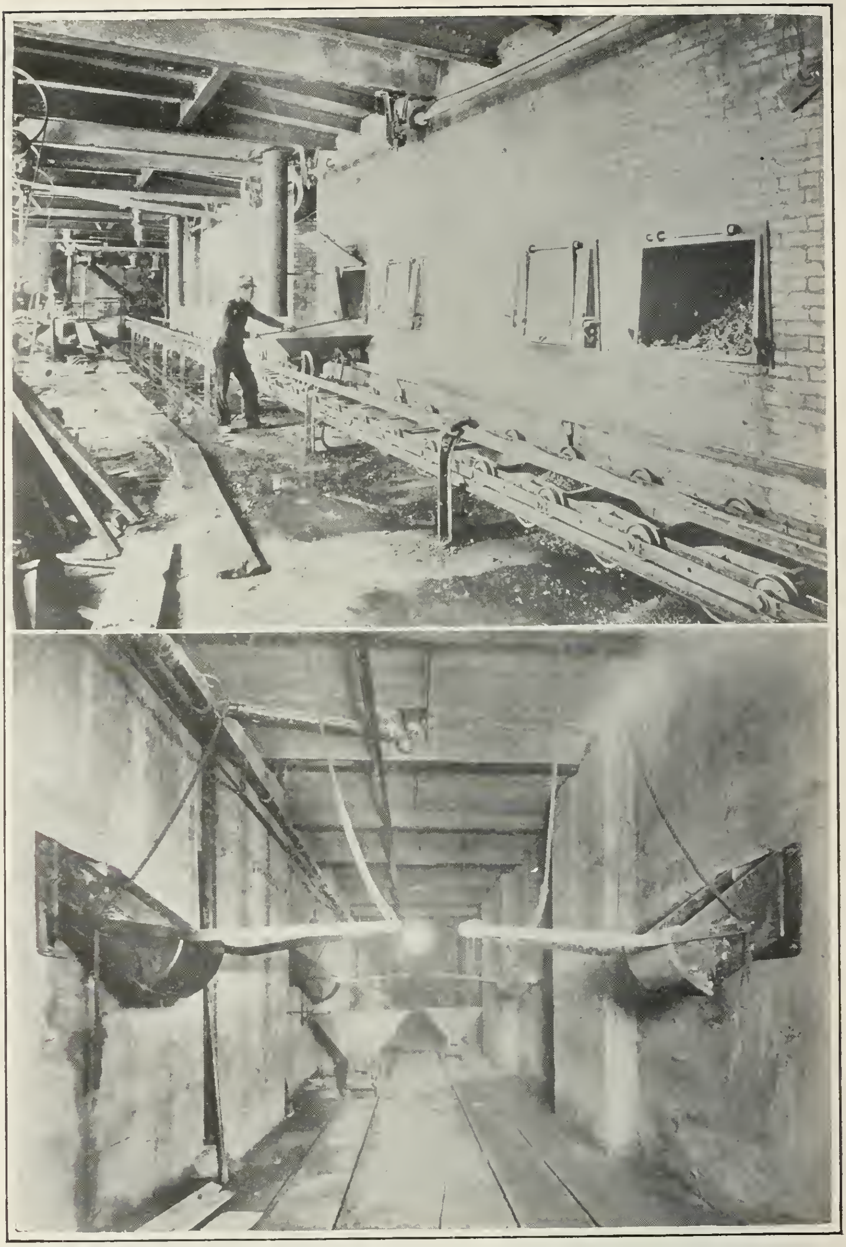
The lower flap is operated by a hand lever and the flow of coal regulated by adjusting the length of the chain. The C. W. Hunt Co., N. Y.

One serious fault with bucket conveyors, in particular, and all link conveyors in general, is the high fibre stresses to which the pins are subjected. This machinery is rarely operated with skilled supervision, and in spite of the best designed automatic oiling devices and dust guards, continual care is necessary in order to guard against the pins



PART OF THE COAL-HANDLING INSTALLATION AT THE SUBWAY POWER PLANT, 59TH STREET, NEW YORK.

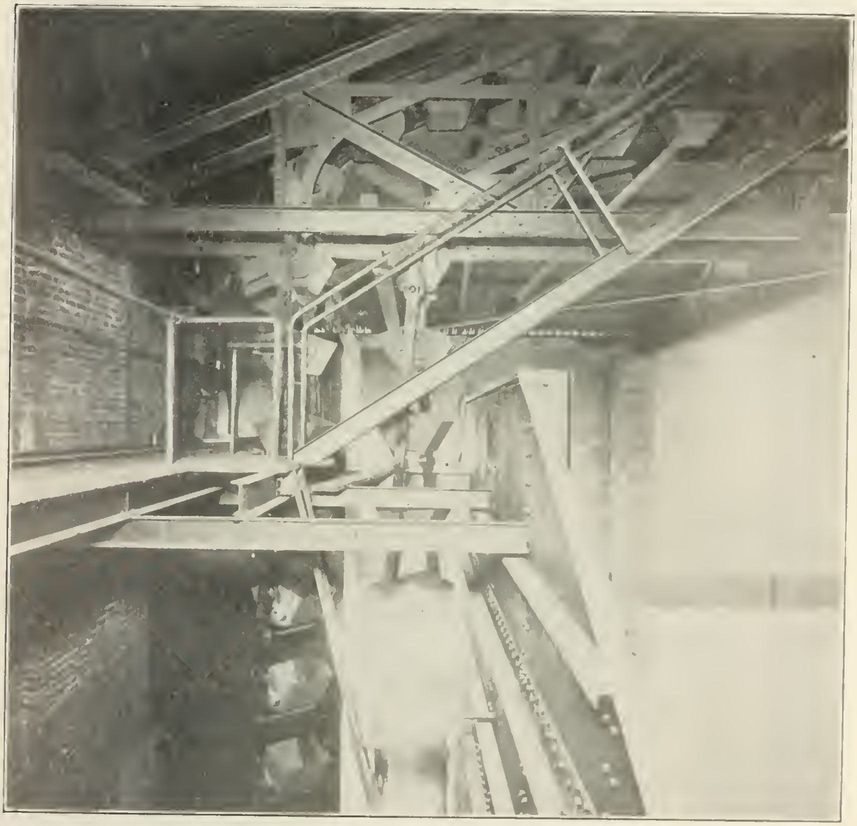
The upper picture shows the inclined conveyor, the lower one the distributing conveyor.
Robins Conveying Belt Co., N. Y.



TWO METHODS OF HANDLING ASHES BY MECHANICAL TRANSPORT.

In the lower one the ashes are drawn through valves into ash cars running on a track; this is at the plant of the Maryland Telephone Co., Balto., Md., and was installed by the Mead-Morrison Mfg. Co. In the upper view the ashes are seen falling into the lower run of a McCaslin conveyor, the installation being by John A. Mead Mfg. Co., N. Y.

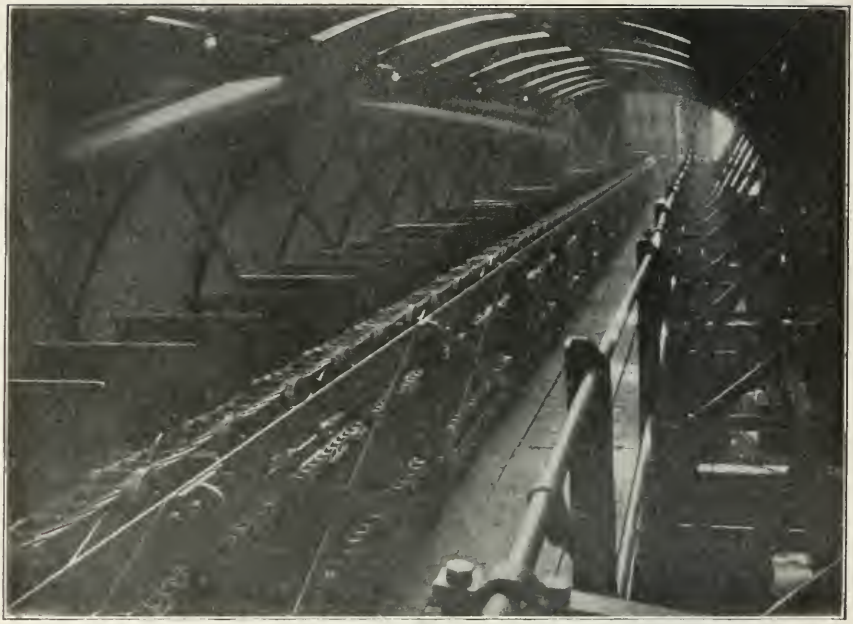
being cut to a dangerous degree in a very short time. Vertical conveyors should be provided with a safety clutch to prevent the loaded leg piling up in the bottom of the shaft should an accidental failure of the driving mechanism occur. In high lifts, where the strain is greatest, I am in favor of arranging latches at intervals which will hold the conveyor should the chain part.



A VERTICAL LINE OF CONVEYOR BUCKETS WITH A TWIST IN THE CHAIN TO CHANGE THE DIRECTION.

The C. W. Hunt Co., N. Y.

In the eastern States "run-of-mine" coal is commonly used, which requires crushing before it is suitably sized for use on mechanical stokers. This necessitates the installation of the crusher close to the unloading machinery. The design of the crusher should be substantial, and whether toothed or grooved rolls are used depends upon the size to which the coal is to be crushed. One element of the crusher is a so-called "breaker"—a cast-iron block designed to break before other portions of the machine have been damaged by any obstruction

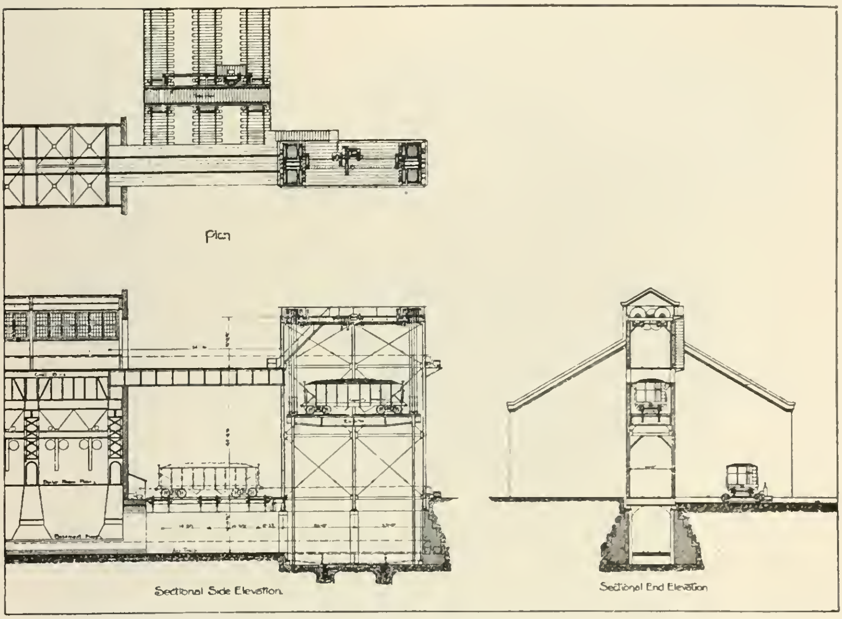


DOUBLE-STRAND ROLLER TYPE CONVEYOR SUPPLYING THE BUNKERS OF A BOILER PLANT.

Capacity 30 tons per hour; 140 feet long, 15 inches wide. By Blake, Barclay & Co.

or hard piece of material. The crusher builder could, with advantage, take a lesson from rolling-mill construction, where in the dark ages breakers were considered to be absolutely necessary, but years ago designers commenced to make the breakers solid and design the mill heavy enough to stall the engine, which is the rational method of treating such classes of machinery. That is, the driving motor should be heavy enough to do its work, but not heavy enough to twist the machine to pieces; this does not mean a reduction in the size of the motor, but an increase in the strength of the other parts of the machine, whose weights have been reduced to the lowest possible limit in order to save cast iron and fill the demand of the concern looking for the lowest bidder instead of the best machine.

Comparatively few plants in the eastern United States are located on railroads, in localities where tide-water frontage can be secured, owing to the fact that coal in cargo lots at the wharf is cheaper than railroad coal delivered on a siding along side of the plant. Clam-shell grab buckets are usually employed for unloading. The hoists are speeded to make between one and two trips per minute, and are operated by either steam or electric power, to suit the demands of the purchaser. The buckets generally have a nominal capacity of one ton,



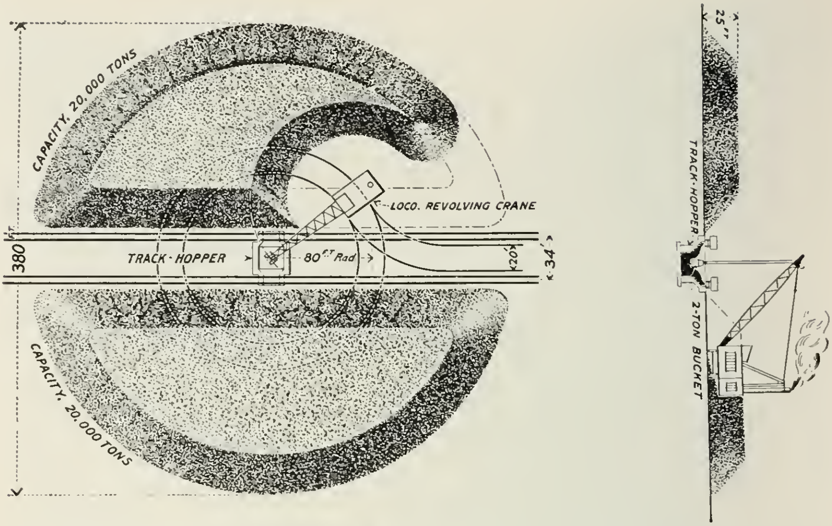
TRANSFER AND ELEVATOR FOR COAL AND ASH CARS, CEDAR AVENUE POWER HOUSE, CLEVELAND ELECTRIC RAILWAY.

Loaded coal cars are raised from railway siding to storage bins over the tops of the boilers, and empty cars are lowered to a basement track running under the ash hoppers beneath the boilers. The transfer table is designed to handle loaded cars weighing 140,000 lb. The elevator works by four hoisting drums geared to work in unison and driven by electric motor. The Wellman-Seaver-Morgan Co., Cleveland, Ohio.

and an actual capacity about 20 per cent less. In a few cases larger buckets are used for coal, while for other materials buckets up to 15-tons capacity are used. In the older hoists chain was employed, but it is uncertain, liable to sudden failures which cannot be well guarded against owing to the fact that chains do not give any premonitory warnings of the approaching failure. Wire rope, on the contrary, gives ample warning of its approaching failure by the breaking of the surface wires, so that there is no excuse for dropping the bucket through the bottom of the barge and blocking up the coal wharf.

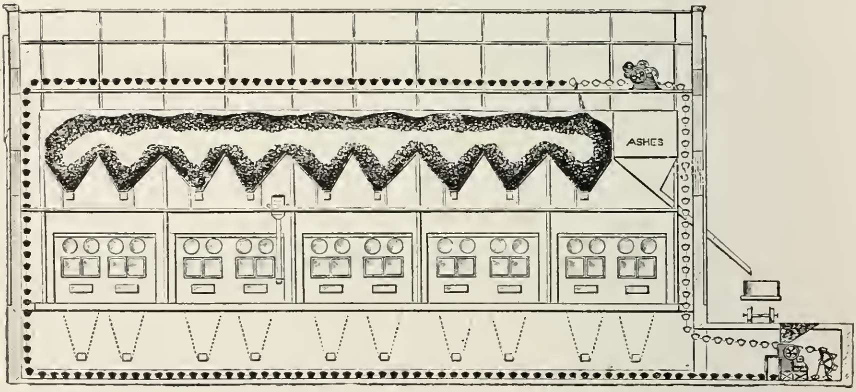
The coal from the bucket is received in a hopper from which it passes to weighing hoppers, and from them into the chute leading to the crusher. In order to prevent the clogging up of the crusher by passing all of the fine coal through it, this chute can be provided with a screen bottom permitting the fine coal to by-pass the crusher and reach the elevator.

The coal-hoisting tower for boat coal is, with a few exceptions, neglected from an architectural point of view. In most cases it has the appearance of being forgotten and left out in the cold. The stand-



DODGE COAL-STORAGE SYSTEM FOR 40,000 TONS BITUMINOUS COAL
SHARON COKE CO., SHARON, PA.

ard finish is corrugated iron—generally galvanized, which does not harmonize well with the main structure. A traveling tower would be rather troublesome to an architect, but it as well as the stationary tower will yield to suitable treatment. Reinforced concrete can be used for sheathing, instead of the more usual materials, and the possibilities in this line are enormous. An example of the rational treatment of the coaling plant to harmonize with the main building is presented in the two recent plants of the New York Central Railroad.



GENERAL ARRANGEMENT OF COAL AND ASHES-HANDLING PLANT, SHEPHERD'S BUSH STATION, LONDON.

Installed by the C. W. Hunt Co.

EDITORIAL COMMENT

IN directing the great sources of power in Nature to the use and convenience of man the engineer has an increasingly difficult task. Not only has he to manufacture power, and apply it to the industrial arts, but he has also to meet the antagonistic forces of Nature and either oppose them successfully, or so divert them as to render them harmless, if not directly useful. In this manner he has made large progress in controlling the winds of the air and the waves of the sea, and now he has before him the task of meeting the waves and tremors of the earth.

Following close upon the disaster at San Francisco comes the report of earthquake and consequent fire at Valparaiso, the great Pacific seaport of South America, and although details of the extent of the disaster are lacking at this writing, it is evident that much damage has been done, not only in the important Chilean seaport, but also in the cities and towns back from the seacoast, in the mountains.

Such convulsions of Nature, with their attendant destructive effects to buildings, water supply, railroads, and other structures, must be met in some way by the engineer, or, failing such control or management, notice must be served upon the inhabitants that they occupy the land at their own risk, and to such great disadvantage as to constitute a permanent handicap to real progress. This latter condition is one which cannot be conceded until the best efforts of engineering skill have been exhausted, and in the present condition of affairs it must be admitted that the earthquake problem has scarcely been attacked at all by the engineer.

The earth tremors which have occurred on the Pacific slope, both in North and South America, appear, in the opinion of the ablest geologists, to be due to subterranean land slips, occurring along the lines of geological faults, and to be altogether free from volcanic origin. This being the case, it rests with the geologist to select the foundation, and with the engineer to insist upon the use of structures of sufficient combined strength and elasticity as to oppose earth movements with the least possibility of injury.

It is no new thing for the engineer to design structures which shall retain their integrity against sudden and violent tremors, but he has not, until now, taken this element extensively into account in connection with buildings. The so-called "elastic theory" has been broadly accepted in opposition to the earlier treatment which assumed the rigidity of the material, and it is about time for the designer to remember that elasticity is a very real property of matter, and that combinations of various materials should be so made that this feature of elasticity should be preserved and even augmented, rather than neglected, and that the apparent solidity and rigidity of great masonry structures, buildings, sea walls, dikes, dams and all the productions of what has been termed "statical" engineering, should be replaced by combinations of stiffness, strength and elastic resilience.

The problem is no new one. Every great railroad bridge has to sustain the shock of impact of advancing trains, and does sustain such shocks and vibrations again and again, rarely failing in service and generally outliving the demands to be replaced only because of the requirements of heavier traffic. When the seismograph is applied to a long-span railroad bridge the indications are more extended, in many instances, than the records of a severe earthquake, and yet the structure withstands such shocks repeatedly, because it has been designed with that end in view.

In like manner the modern transatlantic steamships, exceeding in length more than double the height of the tallest of modern buildings, are exposed almost continuously to shocks and buffetings which would shatter the ordinary building as effectually as any earthquake, and such shocks and vibrations are resisted as a matter of course. Not only is the problem an old one, but its solution is well-known and complete.

It is to the engineer, then, that the architect and builder must turn for instruction in the art of design and construction for earthquake countries, and the engineer in response need evolve no new theories, nor discover no new principles. He may safely apply the methods and materials which he has already tried and proved in locations where vibrations, as severe as any tremors of the earth, are of continual occurrence, and be as assured of the stability and permanence of his work in the one case as in the other.

* * *

The warning uttered in our pages this month by Dr. Louis Bell on the subject of over-specialization is not the first criticism on this tendency that has been made in our pages. As long ago as 1901 the late Mr. Slater Lewis, writing under the title "The Limits of Specialization" in our Works Management Number, called attention to what was at that time not by any means an obvious phase of the question. At that time the so called "American invasion" was in full swing, and the products of American engineering factories were being poured into the British markets in quantities and at prices which seriously threatened the prosperity of many old established firms.

It need hardly be said that this development has fallen far short of its original promise. The threatened mechanical industries of Great Britain are stronger than ever. Indeed, the shock of a suddenly developed and very intense competition served a useful purpose. It led to the abandonment of many methods that were obsolete, and to a study of the whole problem of engineering manufacture from new points of view, distinguishing between practices that were both old and useful and others not only old but also out of date.

But a few—probably very few—observers saw the thing in its true light. They saw that technical evolution was only one side and perhaps a comparatively small side of a complex question. That machine tools *could* be made in enormous numbers precisely like watches was clearly evident, but that they *should* be so made was even then a doubtful proposition.

"Whilst it is true," said Mr. Slater Lewis, "that specialization leads to a gradual transfer of operations from the hands of the engineer to those of the manufacturer, it must not be lost sight of that the manufacturing of engineering articles is somewhat different from any other. These articles are not in themselves prime objects of consumption like silks or condensed milk. . . . Where the technical conditions of the problem favor a uniform product and hence specialization, it does not follow that the latter is commercially possible." This of course is the real crux of the problem. Technically speaking it is possible for specialization of manufacture to be carried to any length imaginable. Commercially speaking we may have to stop short very near our starting point. The demand for any particular product is severely conditioned by a host of causes over which the manufacturer has absolutely no control whatever, and a more hopeless burden than a highly specialized plant of which the product is no longer in demand cannot well be pictured.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

BRITISH EXPORT TRADE.

CONDITIONS INFLUENCING THE EXTENT AND DEVELOPMENT OF THE ENGINEERING EXPORT TRADE OF GREAT BRITAIN.

W. Pollard Digby—Journal of the Society of Arts.

IT is beginning to be generally realised that the engineer is profoundly interested in the economic side of industry, and that the commercial side of life belongs to him almost as much as does the department of production—he must not only know how to make things, but also to sell them. For this reason the paper of Mr. W. Pollard Digby, published in a recent issue of the *Journal of the Society of Arts,* is of value, dealing, as it does with the conditions which govern the disposal of the products of British engineering in all parts of the world.

"Of our present export trade, particularly in engineering articles, much is due to the prior demands of our home industries. Our locomotive export trade is the direct heritage of the internal development which followed the opening of the Liverpool and Manchester Railway. Abroad there arose a desire for railways, and an important export trade arose. Into the economies of external trade it is not necessary to enter here, and speculation may be dismissed as to how far there were or are exports of capital and the manner in which payment was obtained. Pre-eminent in cotton spinning we have equipped the mills of the United States, India, and Japan with machinery, whereby the raw cotton can be worked up nearer to the place of its production. Successful as shipowners of British-made vessels, we became successful as shipbuilders for other countries, it being always remembered that local raw material in the first place rendered it possible to manufacture for our own needs.

"Our trade in machinery, our shipbuilding, and, incidentally, our spinning and weaving industries have been largely aided in their advance by the comparative nearness of our manufacturing centres to the sea. Especially favored in this respect Great Britain has, until recently, been troubled by no misgivings as to her position as the leading manufacturer of machinery and engineering commodities generally in the world. Her output includes iron and steel in forms, cast, rolled, or forged, locomotives, steam engines, pumps, textile and agricultural machinery, electrical goods, and ships of all kinds. In regard to all of these a reputation of first-class work is still the boast of British manufacturers, but a very large proportion of the trade in agricultural, and a large proportion of the demand for electrical machinery in the neutral markets of the world is now met by American and German material. Notwithstanding this competition, regarded externally, British engineering exports are equal in total value to those of Germany and the United States combined, while taken per head of population they are much greater."

According to the statistical figures, quoted by Mr. Digby at length, British export trade in machinery suffered a severe decline after the year 1900, but there has since been a steady recovery, corresponding to declines on the part of Germany and the United States. Some idea of the magnitude of the engineering exports of Great Britain may be gathered from the figures given by Mr. Digby, of which we give only an abstract in round numbers. Thus, during the past year these exports included steam engines for agricultural purposes in value of one million sterling, while locomotive engines were represented by nearly 2½ million, and other steam engines by as much more. Agricultural machinery was exported to the value of one million pounds, and sewing machines were accountable for two millions. Textile machinery was sent abroad worth more than 5½ million pounds, and other machinery amounted in value to nearly 7½ millions. The value of ships sent abroad reached nearly 5½ millions, while manufactured shapes in iron and steel reached a value of nearly 32 millions.

"Among the many features to which attention should be directed in regard to export trade, the packing of machinery and instruments for export is of supreme importance and merits careful attention. The trader whose engineering commodities have, by their superior design and staying qualities, won for him a considerable foreign trade, must become a student of the climatic conditions of the countries to which his manufactures are transported, of the conditions of transport, and facilities for handling his goods, both at the port of landing and up country. It would naturally be extremely prejudicial to electrical machinery, say, if sent in too heavy a package to a port on the African coast; it became subject to all the disabilities of heavy packages removed from cranes and railways, i. e., much levering over, any side up, with as much care and consideration as the ordinary laborer displays towards a package which he considers has been especially sent to strain his sinews, and therefore deserving of some hallmark of his resentment; in some cases even local repacking in smaller boxes becomes necessary for transportation up country, under awkward conditions as to obtaining suitable boxes, packing, and protecting material. If it is found that facilities for handling exist right up to the works (it is not pleasant in England to have machinery delayed owing to the non-existence of a suitable trolley in the neighborhood) well and good. Another class of mishap has been at this end of the transit, i. e., the breaking through of the wheels of the vehicle carrying heavy machinery into an insufficiently-protected sewer, and it is therefore imperative that the weights of packages should coincide with the buyer's requests. Probably a strong heavy package will be best, but in cases where the machinery must be taken over rough roads and light bridges, necessarily it must be split up into a variety of packages, even at the risk of their not all arriving simultaneously. It will be found conducive to satisfaction on the part of the buyer if such things are studied as enclosing spares of the less expensive small parts, such as bolts and nuts, keys, cotters, and other fittings, the losing or breaking of which is not particularly likely, but would, in the case of an oil engine up country, very possibly mean a cessation of running till such time as a new one can be contrived. The co-operation of the buyer who has become intimately acquainted with the effects of climatic and other drawbacks is, of course, very desirable. The exporter must endeavor to see the matter from the buyer's point of view, and the buyer to indicate to him in what way local circumstances differ from the normal."

Many British exports are sent to tropical countries, and Mr. Digby wisely calls attention to the necessity for protection against moisture. Plating, greasing, or otherwise protecting delicate parts against the action of rust, will be found essential, and the climatic conditions at the time of shipment should be observed as well as those of the country of destination, otherwise much dampness and moisture may be enclosed in the packing cases.

"It should not be very difficult to design a special class of machinery suited to the conditions met with in climates presenting extremes of heat and moisture, and this consideration brings us to a very important feature in the export of machinery, i. e., the necessity for standardising, not only each type and set, but every separate part, so that a cabled code-word will be all that is necessary to insure the dispatch of exactly the right size of field coil, or piston rod, or whatever happens to have succumbed. The gradual elimination of awkward projections, or castings calculated to set up strains in cooling, and thus liable to break under slight concussion, has now been going on for some time in the leading ironworks of this country, and it should be possible for them each to arrive at their own especial set of sections, not in a spirit of desire merely to differ from competing firms, but in honest endeavor to improve on their design. In the more delicate electrical instruments necessary in high-tension station work, the packing question is especially important."

Mr. Digby refers to the importance of standardisation as the most practical method of overcoming the disabilities of producing in one country articles especially suitable for use in a totally different one. In this respect the work of the standards committee may be productive of much good, as leading the consulting engineer to specify standard products, instead of requiring fresh types.

There is no reason why standardisation should destroy that competition which is one of the recognized incentives to high-class production. The result of its universal adoption would be to cheapen production to an enormous extent, and consequently leave the manufacturer more chance of excelling by the quality and finish of his work, rather than by a claimed higher output or longer life, difficult to justify in the face of continual changes in the machinery of production and in the continued evolution of improved types.

Mr. Digby advocates increased activity on the part of public officials, in the improvement of consular reports and in the Intelligence Department. At the same time it is important that the merchant himself should use the utmost activity in disseminating information concerning the excellence of his wares, and in this respect much may be learned from his German competitors.

IRON-ORE SUPPLIES.

THE FALLACY OF ALARMIST REPORTS AS TO THE EARLY EXHAUSTION OF THE IRON-ORE RESERVES OF THE WORLD.

John Birkinbine—Iron Age.

THERE has been of late discussion concerning the rate at which the iron-ore deposits of the world are being used up, and some alarmist writers have maintained that before very long the demand will outstrip the supply. This is a question which demands temperate and thoughtful discussion, and it is just such a discussion which is given in a paper by Mr. John Birkinbine in a recent issue of the *Iron Age*.

"The prophecies of exhaustion of iron ore depend for their fulfillment on a practical continuance of existing conditions, such as the relative location of iron ore producing mines, iron ore consuming plants, coal deposits and coke ovens, moderate changes in labor conditions; on labor saving or transportation facilities ceasing to improve; on manufacturing and industrial centers being mainly limited to those now recognized; on little if any progress in the metallurgical processes. Moreover, such prophecies omit the possibilities of other metals or alloys being produced at a cost competing with iron at or near present prices.

"Had the ironmaster of half a century ago been informed that in 50 years the production of iron would reach the quantities now annually made, and had he believed this otherwise possible, he would have prophesied that sufficient ore could not be found to produce such an enormous output, and he would have expressed doubt as to the possibility of obtaining fuel to smelt the ores or of assembling these at blast furnaces.

"Are we not in prognosticating a shortage of iron ore viewing the future with comparatively as little knowledge as the ironmaster of 1856? Naturally each contributor to the discussion views the problem from his country's standpoint. But any estimate of mineral reserve must assume that the whole world has been explored for the specific mineral indicated. Railroads and steam vessels are now absent from few of the geographical or political divisions of the earth, and where other slower or more exhausting means of transportation must be employed the explorer and scientist have not been deterred in their work. But dare we assume, with the present knowledge of geological and physical features, that it is possible to approximate the mineral value of the earth's crust? Little of this has been studied in sufficient detail to place reliable estimates of quantities; in fact, few sections known to contain mineral can be considered as having their reserves demonstrated, as necessity for such demonstration has been wanting."

At the present time the two features of an iron-ore deposit which attract favorable attention are the accessibility of the location and the high iron content, but Mr. Birkinbine shows that these are not necessarily controlling factors. The iron ores of the Lake Superior region were far removed from railroad connections until their operation rendered communication necessary, and now the district is covered with a gridiron of railway lines. In like manner modern improvements enable lean ores to be beneficiated to an extent which enables them to enter the field to advantage.

"The convenience of using ores rich in iron and the facilities for obtaining such material by purchase as wanted have encouraged the transportation of desirable mineral over long distances to furnaces close to which relatively inferior ores lie unused. The freight added to the selling price of these more desirable ores in some instances brings the cost of producing pig metal above what may be expected by using relatively inferior local ores. Iron ores from Minnesota reach Eastern blast furnaces with freight charges representing a cost of 4 cents or more per unit of metal, to which must be added the selling price of the ore, commissions, etc., and interest charges for winter storage. Four cents per unit will go a long way toward mining or beneficiating some ores convenient to blast furnaces which are generally overlooked in estimating reserves. These local deposits may have been wrought by methods in which labor saving appliances were not included, and a use of such methods may materially alter mining conditions. Dividing interest on capital, superintendence, management and fixed charges by a few hundred tons output per annum is quite different from using thousands of tons as a divisor. Many dormant deposits do not encourage the expectation of large reserves; others give indication that the deposits may prove important factors in the future ore supply."

Mr. Birkinbine reviews the estimates made for the Swedish government by Professor Törnebohm, in which the total supply of iron ore for the whole world is placed at 10,000 million tons, or about sufficient for the next 50 years. In this estimate Professor Törnebohm puts the United States down for a 1,100 million tons, this allowing 1,000 million tons for the Lake Superior region, 60 million for the Alabama brown hematites, and 40 million tons for the unmined ores of New York, Pennsylvania, New Jersey, and the western states. That these figures are far too low is evident when it is known that the Lake Superior deposits alone are estimated in the United States to contain 1,500 million tons, while large areas of valuable low-grade ore are not taken into account at all. It is probable that Professor Törnebohm is fairly correct for his own country, and yet he places these deposits as equal to those of Great Britain, twice as great as for Spain, and nearly as great as the United States. Apparently he has shown excessive caution for the deposits about which he has but a secondary knowledge, and his figures should certainly be held subject to revision for other lands than his own. This must be admitted when it appears that he has failed to recognize the known deposits of iron ore in Newfoundland, Canada, Mexico, Cuba, or South America, and but a very small allowance for Asia, and none for Africa. In view the rapid manner in which hitherto unknown deposits have been discovered in the United States during the past score of years, we cannot but believe that other parts of the world may be exploited in a similar manner.

"If we are to estimate the iron ore reserves for future use we must also consider their utilization in the future, a utilization which we have no right to assume will be kept within the limits of present industrial development or transportation facilities, nor even confined to prevalent methods of metal production. They are also to be estimated in their relation to the coal reserves if the metallurgical processes of the present are to be followed. Such consideration may make available some ore deposits which are now remote from commercial centers or distant from exploited coal fields.

"The practicability of electric smelting of iron ore, which has been the subject of detailed study and report, may be of importance in the future, especially in the treatment of ores whose composition or physical condition is in the present status of knowledge undesirable for use in the blast furnace, and experiments with iron sands by the United States Geological Survey offer a possible reserve of iron ore of considerable importance. The same resource, ability and skill which have brought the iron and steel industry to its present status may be counted upon to overcome most of the objections to ores which are impure or distant, and with new metallurgical methods some ores now avoided because of certain elements in their composition may be in demand."

There is no doubt that such inquiries as have been made upon this subject are of much value, and that every effort should be made to ascertain the correct facts. Mr. Birkinbine has been altogether cautious and conservative, and his discussion only shows the necessity of having the ore reserves of each country estimated by an experienced investigator familiar with the actual resources of each region.

"The papers and discussions upon the probable exhaustion of iron ore supplies have served a good purpose in awakening interest in a subject of importance to all who produce, manufacture or use iron or steel. One result to be anticipated is that known deposits of iron ore classed as undesirable by reason of location, apparent volume, physical structure or chemical composition may receive consideration; that some now unopened may be exploited and others which have been wrought in the past may re-enter the list of producers, while encouragement to develop new sources of iron ore may come from the discussion.

"The fact that a number of ores considered unattractive by blast furnace managers can be made available has received more limited attention than would have been given had the better ores been more troublesome to obtain. But roasting pyritiferous ores has been followed for many years; more complete desulphurization and the nodulizing of comminuted sulphurous ores is practiced on a commercial scale; a large tonnage of magnetite is passed through magnetic separators to reduce the silica or phosphorus contents; and practical demonstration has shown that titaniferous iron ore when properly fluxed can be economically smelted. The field for such beneficiating and treatment is large and promises a considerable addition to the iron ore reserves.

"The problem is to be studied from the standpoints of deposits now exploited, of those unwrought, but concerning which ideas of their extent and character have been formulated by exploratory work, and of those whose locations are made known by prospecting, with allowances for probable iron ore supplies suggested by geological conditions.

"The United States by its phenomenal production of iron and steel and incident liberal use of iron ores has invited attention to the depletion of a mineral found in every State of the Union, and present in neighboring countries in volume such as to encourage faith in the future of iron manufacture on this continent. If the study of the iron ore reserves is undertaken in connection with present or possible fuel supplies, with consideration of prospective producing and consuming centers, the time when iron may be a precious metal or the available supply of iron ore become exhausted may be found so far in the future as to allay any anxiety."

This question of the possible exhaustion of the world's deposits of iron ore bears a resemblance to other alarmist predictions about the failure of various natural resources. It was only about a hundred years ago that Malthus predicted that the ratio of increase of population to food supply was such that starvation must soon overtake the world, but that dire fate seems as far off as ever. It is wise to examine carefully into our stock of natural resources, but this should be done rather to guide us in their exploitation than to predict an early impending evil.

THE ART OF INVENTING.

A STUDY OF THE EVOLUTION OF MECHANICAL INVENTIONS IN ACCORDANCE WITH SCIENTIFIC PRINCIPLES.

Edwin J. Prindle—American Institute of Electrical Engineers.

FORMERLY an inventor was supposed to be a sort of brilliant guesser, as often wrong as right, but occasionally hitting, practically by accident, upon some idea of much commercial value. That some inventions of important appear to have been made inadvertently appears to be true, but such examples are rare, and are growing more and more unusual; invention, at the present time, being almost a science, by which new combinations are deduced from observation according to scientific principles. The modern art of inventing, as relating to the devising of improvements in mechanical devices, has been treated in a very interesting manner by Mr. Edwin J. Prindle in a paper presented before the American Institute of Electrical Engineers, and some abstracts from it are here given as of permanent value. Mr. Prindle recognizes the broad meaning of the term invention, including, as it does the original work of the literary man, of the merchant, and of the investigator in general, but he purposely limits himself to the art of making technical inventions, and especially patentable inventions. The importance of encouraging this department of human industry is recognized by nearly all civilized governments by the manner in which they grant an absolute monopoly to an inventor for a limited period of time, in order to encourage him to add to the national wealth for all time thereafter.

"There is an enormous amount of wealth in the United States that is based upon patents. As an instance, might be mentioned the fact that the United Shoe Machinery Company is, by means of patents, able to control the sewing machines upon which ninety per cent. of the welt shoes in the United States are sewed. The Bell Telephone Company, and the Westinghouse Air Brake Company and many other corporations of the first importance built themselves up on patents. Patents have become so well recognized a factor in commerce that, in many lines of manufacture, concerns do not depend simply upon cheapness of manufacture, or quality of product, to maintain their trade, but they count on always having a product which is at least slightly better than that of their competitors, and which is covered by patents, so that they do not have to compete with an article of equal merit. And they keep a corps of inventors at work in a constant effort to improve the product, so that, when the patents now giving protection have expired, they will have a better article to offer, also protected by patents.

"Inventing has become almost a recognized profession. Many large concerns constantly employ a large corps of inventors, at liberal salaries. Besides the inventors employed by large corporations, there are many inventors who have maintained their independence, and are free lances, so to speak. Some inventors have become wealthy almost solely by their inventions, such as Edison, Bell, Westinghouse, Marconi, Pupin, Tesla, and Sprague. A considerable number of the smaller manufacturing concerns are built largely or wholly upon the inventions of their principal owners.

"Aside from the question of financial returns from inventing, the inventor has the satisfaction of knowing that he is a producer of the most fundamental kind. All material progress has involved the production of inventions. Inventors are universally conceded to be among the greatest benefactors of the human race.

"The art of invention is therefore one of great commercial and economical importance, and it becomes a matter of much interest to know how inventions are produced."

It is an interesting psychological study to inquire into the mental processes by which inventions are evolved, and in the course of his experiences with inventors of every class Mr. Prindle is able to furnish some very interesting notes upon this department of thought and work.

"It seems to be popularly believed that the inventor must be born to his work, and that such people are born only occasionally. This is true, to a certain extent, but there are many people who, without suspecting it, have latent inventive abilities, which could be put to work if they only knew how to go about it The large percentage of inventors in this country compared with all other countries, shows that the inventive faculty is one which can be cultivated to some extent. The difference in ingenuity is not wholly a matter of race, for substantially the same blood exists in some other countries, but it is the encouragement of our patent laws that has stimulated the cultivation of this faculty.

"The popular idea seems to be that an invention is produced by its inventor at a single effort of the imagination and complete, as Minerva sprang full grown and fully armed from the mind of Jove.

"It is, undoubtedly, true that every inventor must have some imagination or creative faculty, but this faculty may be greatly assisted by method. While reasoning does not constitute the whole of an inventive act, it can, so to speak, clear the way and render the inventive act easier of accomplishment."

It has been held that that which can be produced purely by processes of reassoning and inference is not an invention in the patentable sense of the term, but that the imaginative or creative faculty must be used somewhere in the process. It is this element in the operation which was so clearly indicated by Tyndall in his essay "On the Scientific Use of the Imagination," and as Mr. Prindle well puts it, it is the part of science to reduce the leap from the known to the unknown by means of the imagination.

After defining protectable inventions as falling within some one of the four classes of Arts, Machines, Manufactures, and Compositions of Matter, Mr. Prindle proceeds to define these classes and illustrate them by actual examples. In so doing he adds one more to the many definitions of a machine, one which will bear repeating as being briefer, and nearly as precise as the classical definition of Reuleaux. Reuleaux says: "A Machine is a combination of resistent bodies so arranged that by their means the mechanical forces of Nature can be compelled to do work, accompanied by certain determinate motions." Mr. Prindle says that a machine is "an assemblage of two or more mechanical elements, having a law of action of its own."

"Having selected a problem, the next step should be a thorough analysis of the old situation, getting at the reasons for the faults which exist, and in fact discovering the presence of faults which are not obvious to others, because of the tendency to believe that whatever is, is right.

"Then the qualities of the material, and the laws of action under which one must operate should be exhaustively considered. It should be considered whether these laws are really or only apparently inflexible. It should be carefully considered whether further improvement is possible in the same direction, and such consideration will often suggest the direction in which further improvement must go, if a change of direction is necessary. Sometimes the only possible improvement is in an opposite direction. A glance at the accounts of how James Watt invented the condensing steam-engine will show what a large part profound study of the old engine and of the laws of steam played in his invention, and how strongly they suggested the directions of the solutions of his difficulties.

"We now come to the constructive part of inventing, in order to illustrate which, I will seek to explain how several inventions were, or could have been, produced.

"The way in which the first automatic steam engine was produced was undoubtedly this—and it shows how comparatively easily a really great invention may sometimes be made. It was the duty of Humphrey Potter, a boy, to turn a stopcock to let the steam into the cylinder and one to let in water to condense it at certain periods of each stroke of the engine, and if this were not done at the right time, the engine would stop. He noticed that these movements of the stopcock handles took place in unison with the movements of certain portions of the beam of the engine. He simply connected the valve handles with the proper portions of the beam by strings, and the engine became automatic—a most eventful result."

Mr. Prindle further illustrates the processes of invention by two concrete examples, one being the evolution of a special form of time-stamp, and the other a cord-knotter for a self-binding harvester, the successive details being well shown by illustrations, and closes with some remarks upon the fact, well-known to every inventor, that the mind proceeds, in nearly every instance from the more complicated to the simpler device.

"In inventing a machine to operate upon any given material, the logical way is to work from the tool to the power. The tool or tools should first be invented, and the motions determined which are to be given to them. The proper gearing or parts to produce from the power each motion for each tool should then be invented. It should then be considered if parts of each train of gearing cannot be combined, so as to make one part do the work of a part in each train; in short, to reduce the machine to its lowest terms. Occasionally a mechanism will be invented which is exceedingly ingenious, but which it is ,afterwards seen how to simplify greatly at the expense of its apparent ingenuity. This simplification will be at the sacrifice of the pride of the inventor, but such considerations as cheapness, durability and certainty of action leave no choice in the matter. It will sometimes be found that a single part can be made to actuate several parts, by the interposition of elements which reverse the motion taken from such part, or which take only a component of the motion of such part, or the resultant of the motion of such part and some other part. Where a machine involves the conjoint action of several forces, it can be more thoroughly studied, if it is found there are positions of the machine in which one force or motion only is in operation, the effect of the others in such position being eliminated, and thus the elements making up the resultant effect can be intelligently controlled."

MODERN PRACTICE IN REINFORCED CONCRETE.

OPERATIVE METHODS FOR CONTROLLING PROPORTIONS AND REDUCING COSTS OF STRUCTURES OF CONCRETE AND METAL.

E. P. Goodrich—Association of Portland Cement Manufacturers.

REINFORCED concrete has taken a place among the recognized methods of building construction to such an extent that experience is becoming crystalized into standard methods, and hence the time is at hand when the earlier empirical rules for proportions and details should be discarded. Apart from the general adaptability of reinforced-concrete construction to nearly all kinds of work one of its great advantages has been stated to be its moderate cost. The result has been, in some cases, too great a desire to secure cheapness, followed by failure and dissatisfaction, while in other instances the full benefits and advantages of the system have not been realized. In a paper presented at a recent meeting of the Association of American Portland Cement Manufacturers by Mr. E. P. Goodrich the best features of present practice are brought, with a special intention of discussing the elements involved in effective cost reduction of the finished work.

As an indication that some such discussion is appropriate at the present time, Mr. Goodrich gives some examples of extremes in the proportions of executed structures.

"One building has floors designed throughout 100 per cent thicker and with 100 per cent more steel than is necessary. Furthermore, 100 per cent more cement was used than was possibly required. In another piece of work a retaining wall of solid concrete 2 feet thick and 6 feet high was reinforced with five-sixteenth-inch rods spaced 2 feet apart. Of course, the rods will do no hurt in the wall. Happily, no danger is involved in those two structures, but many others exist which would long since have collapsed if loaded to any great percentage of what they are supposed to be able to support. One such building designed for floor loads of about 150 pounds showed signs of great distress when tested to only 75 pounds."

Mr. Goodrich shows that he appreciates

very clearly the fact that the highest mechanical efficiency does not necessarily mean the highest commercial efficiency, and the whole purport of his paper is to show how to secure the best structure at the minimum cost in money. In so doing he discusses both the materials themselves and the method of handling them.

"Of course, elements other than cement enter the problem to effect irregularities in tests, but it would be a great step in advance if cement could be so manufactured as to give as uniform tests as does steel. Then it would be possible for the engineer to reduce the larger factor of safety now demanded for concrete over that required for steel in reinforced concrete beams. Such a cement could actually demand a differential in price over the present qualities, and would be given it by many engineers. Another important point in which cement might be improved in its special relationship to reinforced concrete work, is its resistance to compression. The tendency for both mechanical and economic reasons now is toward the disuse of longitudinal reinforcement in concrete columns. But six, five, or even three-foot columns, such as are now necessary, are out of the question for most work and a much better grade of cement would receive an enthusiastic reception by all engineers.

"With regard to the item of strength of reinforced concrete, the ideal will be realized when the designer can so proportion the several parts that all will theoretically be worked to equal efficiencies, and those the maximum safe ones; and the superintendent of construction can so erect the structures as to conform exactly to the design prepared."

The quality of the cement being determined by specification, the controlling element in the quality of the concrete is the amount of cement used, together with the nature of the materials which it is used to bind together. The poorer the mixture the lower the cost of a cubic yard, but the cheapest concrete is not the most profitable, and the character of the mixture should be governed by the conditions of use. Mr. Goodrich gives diagrams showing the cost of different mixtures per pound of safe compressive stress, from which the selection may be made according to the nature of the structure and the character of the loading.

"Turning from the ingredients to the methods of handling them, three or four cardinal principles may be laid down with regard to the operations to be carried on.

"A fundamental principle to be observed in the handling of concrete materials is to make as much use of gravity as is possible. Especially in large work it is usually more economical to carry all materials to the tops of bins or other structures from which point they can move by gravity down through the mixer into the conveying devices. Every one is familiar with the high trestles, bins and other devices adopted on all large enterprises for the storage and handling of concrete materials.

"In general it may be said that the mixing should be done as near the point of installation of the concrete as possible, since it is easier and cheaper to handle the dry material than the wet mixture. In the case of one large building with structural steel frame, a small electrically-driven portable mixer was employed and moved about so that it discharged directly at the point where the concrete was to be placed. Electric power and water could be conveyed with ease to all parts of the building by wire and hose, and, with the structural work in place, the dry materials could easily be hoisted and conveyed to the mixer. This arrangement is perhaps ideal, but every effort should be put forth to make as short as possible the distance which the wet concrete has to be conveyed. Of course, the quantities to be handled, the time in which the work must be completed, and the height of the structure are the factors which determine most completely how much and what mechanical appliances can be used.

"The great point in arranging the labor in connection with a piece of work is to have an organization which will run like a clock. Such an organization will have no superfluous members, and will work with no irregularities of action. A few extra men to do nothing but maintain proper runs for the wheelers, can often actually effect a considerable saving of time and money. Under most conditions operations should be carried on in circles and cycles. Workmen should never turn abruptly and return over the same path, but should always return by another road, thus completing a circuit and thereby preventing confusion and delay. By making all operations consist of simple cycles, each workman becomes expert in his duties and works most efficiently."

As regards hoisting the wet concrete or the moulded forms, platform elevators, bucket hoists, or derricks may be used, the choice depending so much on local conditions that no positive preference can be stated. The actual cost of the hoisting of the material is sometimes a minor element in the choice, the handling of other material, and the general value of the appliances to the contractor in his current work being often the ruling factors.

"The style and design of the steel reinforcement for concrete work is in no sense as well established as to economy and efficiency of design and construction as are the preparation and mixing of the concrete elements. There are at the present time a dozen or more fairly well-known systems, so called. The first tendency in this country was toward peculiarities of structure of the reinforcing bar so as to develop the adhesion between the steel and the concrete. At the present time the subject of adhesion is giving place to that of shear and the use of stirrups is receiving special attention in theoretical discussions. But even now the whole subject is assuming a phase in which theory is being largely modified by experimental results and practical conditions, and engineers are adopting short methods and thumb rules in making up designs. To be sure, they are not the same sort of rules as those so widely employed in some empirical systems, however closely the former may approach the latter. This is true because of the tedious study of theory from which the present practice has been derived."

Since the general introduction of reinforced concrete in construction, innumerable so-called systems have been introduced, the characterizing features of these being mainly in the form and character of the reinforcing material. As a matter of fact results of such excellent character may be attained by the simple methods long since open to the public, that it is unnecessary for engineers to do more than require materials of good quality to be used, and to dispose them in accordance with correct scientific principles.

"It is believed that at the present time the tendency is away from the use of special patented bars toward the use of plain round ones; and away from what may be designated as 'discrete' systems toward what may be termed 'unit systems.' It is believed further to have been demonstrated, in at least one special case, that such units can be fabricated and placed at just as economical costs as can be secured with any system using discrete members. While the same statement cannot be truthfully made with regard to lesser efficiencies of steels with a high elastic limit when the same is due to a large percentage of carbon, still it is looked upon with much distrust by many engineers, and it is believed that its use is not increasing with the relative speed that is being maintained by steel with low carbon. Where the increased elastic limit can be secured by cold rolling or twisting, many of the objections to steel with high carbon are groundless, but the very fact that smooth round rods of standard quality can easily be secured with less cost, time and trouble gives them a predominant advantage. Many engineers will not agree with these statements of tendency at the present day, but practice as described in current technical literature seems to point in the direction stated."

The most economical ratio of areas of steel and concrete to be used in beams has been a subject of much discussion, mathematical and otherwise, and it is evident that the highest efficiency, mechanically speaking, is attained when the concrete is stressed to the maximum compression efficiency at the same time that the steel is subjected to the maximum tensile efficiency. Mr. Goodrich gives several curves, showing the ratios of maximum mechanical efficiency and the highest commercial efficiency, the latter taking the question of cost into account, and in general it appears that the best ratio is between 1 per cent and 1½ per cent of reinforcement.

A very important element in the cost of reinforced-concrete structures is the cost of wooden centering and falsework. It is this point which renders it often more advantageous to use beams manufactured elsewhere than to build the entire structure from wet concrete on the spot. Even if made on the ground, it will be found cheaper to form the columns, beams, and repetition parts in moulds on the ground, rather than to use the expensive amount of timber necessary to cast everything in position. A form of construction described in detail involves the use of brick curtain walls, with vertical slots left in the brickwork in which the columns which support the loads may be cast in concrete, with a minimum of wooden casing. Sheet metal moulds and core boxes may also come into use especially if standard sizes of columns and beams are adopted, as well as for large structures in which the amount of repetition work warrants the initial cost.

"Great care should be taken in the design of all centering, to make it as readily erected and removed as possible. It is believed that fully as much time can be profitably devoted in the office to the careful design of the centering for a job, as to the design of the reinforcement. As to the latter, it is believed that each beam and other member should be as carefully analyzed as are complicated plate girders. Regular strain sheets should be prepared and preserved for record, and all elements carefully investigated. Another point for careful study in the office is that of reducing to a minimum the number of types of beam reinforcement to be used on a building. This item is even more important than in the design of structural steel work, where it is made a cardinal point. Reinforcement and centering should be made interchangeable from bay to bay and from floor to floor as far as possible. Very often a design can be altered so that this can be effected with great economic advantage and with little or no loss of architectural or other feature."

THE FIXATION OF ATMOSPHERIC NITROGEN.

COMMERCIAL SUCCESS IN THE OXIDATION OF ATMOSPHERIC NITROGEN BY THE USE OF ELECTRIC ARCS.

Prof. Kr. Birkeland—The Faraday Society.

WE have already reviewed in the land and Eyde, in Sweden, in the columns the work of Messrs. Birke- conversion of the nitrogen of the air into commercial nitrates, suitable for fertilizing purposes, and now we have a fuller authoritative account of this important industry in the form of a paper presented by Professor Birkeland himself before the Faraday Society, which gives the present state of the process.

The principle upon which the process is based may be briefly stated as follows:

When two pointed copper electrodes, attached to a high-tension alternator, are placed equatorially between the poles of a powerful electro magnet, in such a way that the terminals of the electrodes are in the middle of the magnetic field, an electric flame will be formed in the shape of a flat disc. By keeping the electrodes cooled with a water circulation they will last for many hours, and practical experience has shown that a disc flame of this kind of about two metres in diameter may be maintained by a pressure of 5,000 volts, at 50 periods per second.

"The formation of these disc-flames may be explained in the following manner: At the terminals of the closely adjacent electrodes, a short arc is formed, thus establishing an easily movable and ductile current-conductor in a strong and extensive magnetic field, *i. e.*, from 4,000 to 5,000 lines of force per square centimetre in the centre. The arc thus formed then moves in a direction perpendicular to the lines of force, at first with an enormous velocity, which subsequently diminishes; and the extremities of the arc retire from the terminals of the electrodes. While the length of the arc increases, its electric resistance also increases, so that the tension is heightened until it becomes sufficient to create a new arc at the points of the electrodes. The resistance of this short arc is very small, and the tension of the electrodes therefore sinks suddenly, with the consequence that the outer long arc is extinguished. It is assumed that while this is taking place the strength of the current is regulated by an inductive resistance in series with the flame.

"The extremities of an arc may sometimes appear like glowing spots upon the backs of the electrode. The spots of light on the positive electrode are small, and lie exceedingly close to one another, while those on the negative electrode are larger, and the distance between them is greater. The reason of the appearance of these spots of light is that the arcs, so to speak, melt or solder themselves to the electrodes, so that the magnetic force can only make the extremities of the arcs move along the electrodes in tiny leaps. It is evident from the curvature of the arcs that they cling more closely to the negative than to the positive electrode; and, therefore, the flame extends farther along the positive electrode than along the negative.

"When the flame is burning it emits a loud noise, from which alone an impression may be obtained of the number of arc formed per second in the flame. If the matter is to be more minutely investigated, this may be done by the aid of an oscillograph, by means of which the tension-curve for the electrodes, and the current-curve, can easily be drawn."

When a current of air is passed through such a disc flame a combination of a portion of its oxygen and nitrogen takes place, the result being a production of nitric oxide, and from this the production of commercial nitrates is a simple operation. In the Birkeland furnace the arrangement is such that the disc flame is formed in a vertical plane, the furnace being narrow, only 5 to 15 centimetres wide, the air being driven in at the centre from a pressure blower, and passing radially through the flame disc and conducted away through a peripheral channel. Although the temperature of the flame is higher than 2,500 degrees centigrade, the temperature of the furnace walls does not rise above 700 degrees, owing to the cooling action of the air.

"The nitric oxide fumes which are formed in the furnaces and conducted away with the hot gases, fixate, after cooling, a further quantity of oxygen from the unconsumed part of the air, and turn into nitric peroxide; and this, when treated with water, combines to form nitric acid.

"The volume of air thus treated at present in the Notodden saltpetre manufactory is 75,000 litres per minute; and as it contains only about 1 per cent of nitric oxide, it will easily be understood that in discussing the question of obtaining nitric acid from the air, it has frequently been pointed out that the great rarefaction of the gases to be worked with, greatly enhances the difficulties of the problem to be solved.

"The gases that come from the furnaces with a temperature of 600°C. to 700°C. first pass through a steam boiler, the steam of which is employed in the further manufacture of the ultimate product, calcium nitrate. In the saltpetre manufactory now in course of erection, the gases will be conducted directly through the evaporation tank, an arrangement which implies such an important saving of heat, that the employment of coal may presumably be avoided.

"After the gases are discharged from the above-mentioned steam boiler, their temperature is reduced to 200°C, whereupon they are conducted through a cooling apparatus to be further cooled to about 50°C. The more the gases are cooled, the more easily are they absorbed by water. The gas then enters two large oxidation chambers with acid-proof lining. Here, as already mentioned, takes place the oxidation of the compound formed in the furnaces, nitric oxide becoming nitric peroxide, which is then conducted farther into an absorption system, where the gas is converted into nitric acid.

"The absorption system consists of two series of stone towers, whose internal dimensions are 2 by 2 by 10 metres, each series containing five towers, two of granite and two of sandstone, filled with pieces of quartz, over which water, and the nitric acid formed, are made to trickle, while the fifth tower in each series is filled with ordinary bricks, over which trickles milk of lime. The milk of lime quickly absorbs the rarefied nitrous gases remaining, and is converted into a compound of calcium nitrate and calcium nitrite.

"The first tower yields a 50 per cent nitric acid, the second about 25 per cent, the third 15 per cent, and the fourth 5 per cent. The liquids from the fourth tower are raised by compressed air to the top of the third, those from the third to the second, and those from the second to the first, thus gradually increasing in concentration up to 50 per cent., at which density the acid is conducted into a series of open granite tanks, where it is temporarily stored.

"Some of this acid is employed in the decomposition of the nitrate-nitrite combination obtained by absorption by milk of lime. By the addition of nitric acid the nitrous anhydride contained in the nitrite is driven out and carried back to the system of towers.

"The solution resulting from this, containing pure calcium nitrate, is carried, together with the rest of the stored-up acid, into another series of granite tanks, where this mixture of acid and acetous calcium nitrate lye, reacting on ordinary limestone, is converted into a solution of neutral calcium nitrate. This neutral lye is carried farther into vaporisation chambers of iron, where it is vaporised to a boiling point of 145°C., answering to a concentration of from 75 to 80 per cent of calcium nitrate, containing about 13.5 per cent of nitrogen. This substance is then run into iron drums containing about 200 litres, where it congeals, and in that form appears on the market."

Experiments made with the calcium nitrate as a fertilizer show it to be fully equal to the natural saltpetre, and if the process for its manufacture can be conducted at a cost which is commercially practicable the problem of the production of an artificial fertilizer for grain may be said to be solved.

While full disclosures of operative costs cannot be expected, Professor Birkeland gives enough information to show that the process can be operated so as to enable the product to be sold for £8 per ton, the works cost being about one-half this amount. It appears that the output of the present furnaces corresponds to between 500 to 600 kilogrammes of anhydrous nitric acid per kilowatt per year, so that, the cost of power being determined, the other costs should be capable of determination.

The new works, now nearly completed, are to obtain 30,000 horse power from the falls at Svaelgfos, and when this is in operation is is expected that closer cost data will be forthcoming. In the construction of these works it appears that the cost per kilowatt for the erection of furnaces, is £1,000, fully complete, including inductive resistances, ready for connection to the alternating current, for a 1,000 kilowatt furnace, so that a basis for the installation cost is also given.

Professor Birkeland concludes his paper with a valuable theoretical study on the oxidation of nitrogen, with photographs of the flame, and data of experimental researches, his conclusions leading him to believe that the action is a thermal rather than an electrical one.

COMMERCIAL DRY DOCKS

A STUDY OF TYPES, DIMENSIONS AND DETAILS OR DRY DOCKS FOR THE HANDLING OF MERCHANT VESSELS.

J. M. Moncreiff—North-East Coast Institution of Engineers and Shipbuilders.

NEARLY every department of engineering work is so intimately bound up with some other portion that is impracticable to consider one thing without necessarily taking many others into account. The present tendency in shipbuilding is an excellent instance of the truth of this statement. Vessels are being constructed of greater length beam, and draught than ever before, in accordance with the demonstrated fact that large vessels and the most profitable of cargo carriers. But large vessels mean enlarged harbors, deeper channels, greater handling facilities, and larger docks. This latter question, the construction of dry docks for modern merchant vessels, formed the subject of an important paper, presented several months ago by Mr. J. Mitchell Moncreiff before the North-East Coast Institution of Engineers and Shipbuilders, and followed for several meetings by an animated discussion. While Mr. Moncreiff discusses principally the conditions existing on the Tyne, the principles of constructions brought out in the paper and in the discussion are of such general applicability as to merit review and comment in these pages.

Taking up first the question of dimensions, Mr. Moncreiff begins by showing that a dock of 550 feet length, by 65 feet width of entrance, by 14 feet depth over the sill at low water and 29 feet at high water could probably deal with every commercial vessel ever cleared from the river Tyne up to the end of 1904, and he believes that only a moderate increase over these dimensions should be provided at the present time. For other ports, however, the record of vessels entering and building should be taken into consideration, especially as to width and depth, and that the plans should include provision for future lengthening, this being the dimension in which further immediate increase is likely to be expected.

Dimensions having been determined, the next question for consideration is that of site. This, however, is not usually a matter of selection, but rather of utilization of land already available, its nature having important influences upon the design of the structure.

"Where, however, it is possible, the selection of the site should be done in the most careful manner, and the mere fact of a certain piece of land being obtainable at a reasonable figure should not be allowed to be a ruling factor in coming to a decision. Instances are not wanting of docks, which, from lack of proper consideration and enquiry, have been saddled with heavy capital outlay which taxes their dividend-earning powers to the utmost. In every case numerous borings should be taken over the proposed site, and the small outlay required would be amply repaid by the greater certainty and accuracy with which the designs could be got out and by the greater confidence with which contractors would be able to fix their prices when tendering for the work. The omission to take a sufficiency of borings leaves an open door for claims for heavy extras.

"The character of the subsoil of a site has very great influence on the design and cost of a dock. Generally a rock bottom is most to be desired, but this is not an invariable rule; hard boulder clay is excellent, while the softer clays, alluvial deposits, ground of mixed character, and water-bearing sand, give most trouble during construction. Instances of some of these will be described later. In choosing a site it should be kept in mind that it is a great advantage for a dock company to have more than one dock, or at least to have a site which will allow of more than one dock being constructed upon it. It is also a great advantage for dry docks to be associated with a shipyard for reasons which are sufficiently obvious.

"If possible there should also be provided a repairing berth with ample depth of water, and a wharf at which such repairs may be carried out or completed as do not necessitate the vessel being in dock. The site should have room for the various workshops, stores, and offices required."

In order to show the influence of the character of the subsoil upon the design and cost of a dock Mr. Moncreiff discusses the cross sections of several docks which have been actually executed. When the site consists of rock, capable of carrying heavy loads with safety, and not sufficiently permeable to permit serious upward pressure from water, the construction becomes greatly simplified. The bottom need be only sufficient to insure tightness and a smooth surface, while the lower portions of the walls form struts to support the upper portions subjected to the overturning efforts of earth and water pressures behind. When the bottom is not so good its defects must be remedied by heavier artificial structures, and Mr. Moncreiff gives several examples of such construction for different kinds of soils.

"In determining the cross section of a commercial dock the inner contour is designed almost wholly with regard to having a sufficient clear space around and under a vessel to allow paint to dry quickly, to provide room and light by which repairs can be carried out with ease and promptitude, and to give altars for the support of shores. It is now customary to provide only a few altars in the upper half of the wall face, of such width and height that workmen can pass with ease and safety from one to the other or along any one of them. At the foot of the wall one or two low altars are sometimes also provided, but their function is not solely that of an altar properly so called, but also that of a toe to the dock wall.

"The large number of altars provided in most of the older docks, and the consequent great width between the copes, are not necessary or desirable at the present time. The great width at the copes would cause much unnecessary pumping, and the great distance of the copes from the centre line of the dock, and consequently from vessels in the dock, would require cranes of very large radius, and this of course would entail extra weight and size of cranes to give sufficient stability. In addition to these inconveniences, an excessively wide dock takes up valuable space which might be otherwise occupied.

"Steps or reductions in thickness should rarely, if ever, be made at the back of dock walls, as it is almost impossible to prevent some little movement of the backing if the wall back be not built hard up against the earth face so as to avoid having to remove timbering to put in filling."

Mr. Moncreiff discusses at length the important question of the construction of gates for dry docks, especially in connection with the relative values of gates and caissons.

"The gates may be of wood, iron, or steel, or of a combination of these materials. For the smaller class of docks, say with entrances of not more than 45 feet wide by 25 feet total depth from cope to sill, pitch-pine timber gates are quite satisfactory, and are also very durable except in situations where the ravages of marine worms are to be feared. For the larger commercial docks timber gates are too heavy and cumbrous. Composite gates having iron or steel ribs with timber planking are also sometimes adopted and are very economical in first cost. For the larger and more modern docks, however, the gates will usually require to be of steel or iron throughout, in order to provide the strength required to sustain the great depth of water over the sill at high tides, and at the same time to be comparatively light and easily worked. It has sometimes been urged that the timber gate, by reason of its greater mass and solidity, is superior to the steel or iron gate in the event of being struck by a vessel; but this advantage is more imaginary than real, and there is no reason why gates for commercial dry docks should be specially made to resist collision any more than the vessels which the dock is constructed to contain. If this principle of making structures capable of resisting any and every possible contingency were to be carried out consistently, it would result in an enormous and unnecessary waste of money."

So far as operative machinery is concerned, it appears to be possible to go too far in this direction. Some docks are equipped with expensive hydraulic or electric machinery for the operation of the gates, but the time saved by such appliances is so small as to render but slight return upon the original cost. The gates of any modern-sized dock can be opened by hand gearing in three or four minutes, and if a little higher speed be desired it can be obtained by the aid of an ordinary steam winch or electric capstan. Even if special motive power is installed an auxiliary hand gearing should be provided.

"A matter which has very frequently been discussed is the question of the relative advantages and economy of caissons as compared with gates. There cannot be a doubt as to which is the less costly, even if the caisson be merely swung out into the river without any special provision in the nature of a caisson-chamber. If the latter be also provided it will, in the case of the large docks now required, add a very large sum to the first cost. It is to be remembered also that the chamber for the caisson must necessarily be placed at the very point where it is most desirable to avoid any unnecessary constructive work, that is, just at the very entrance of the dock, and it will entail a much larger coffer-dam than would otherwise be required and will increase the risks which are inseparable from the construction of the river-end of any dock.

"It is more than 150 years since Belidor strongly urged that the entrance of a dock should be the first part to be constructed. This is now more than ever necessary, in view of the far greater depths to which both permanent and temporary works have to be carried, and there is, at the present day, every reason to endorse Belidor's opinion, in order to avoid working for any lengthy period behind a temporary coffer-dam. It is, therefore, for a commercial venture, a mistake to increase the constructive work to be done at the river-end of a dock, unless some very substantial advantages are to be afterwards gained. In general there are not sufficient advantages in the provision of a caisson-chamber to justify the extra expense and risk, and having regard to all the circumstances it appears that the balance of advantages is very greatly in favour of gates as compared with caissons, at least for commercial enterprises.

"It is sometimes claimed that a longer dock can be obtained with a caisson than with gates, but this is not found to be correct in practice. Gates are undoubtedly much less costly, they are handier and quicker in working, they are not liable to get adrift, and they do not require special pumping engines and boilers, and special men to attend to them."

The pumping machinery for dry-dock service demands no especial attention, except that it appears more than probable that electric power will be found increasingly available. thus dispensing with a large portion of the steam-power plants hitherto necessary at locations where much inconvenience was caused and valuable land occupied.

The use of concrete for dock construction is unhesitatingly advocated by Mr. Moncreiff in connection with a strong appeal for the highest class of work. Concrete is attacked by sea water if it is not of the best, and the work executed in the very best manner. The walls should be faced with a hard brick skin, and the tops of the altars and the copes should be of granite. This adds materially to the cost, but the best is none too good in such work.

In the course of the discussion it was brought out that for general service modern dry docks should be built capable of dealing with vessels 800 feet long and 80 feet beam, and it is a question whether even these dimensions are not soon to be exceeded. The question of floating docks was also discussed at length, and it appeared that these are distinctly more costly than dry docks in first cost, but not necessarily so in operation.

THE GOLD PRODUCTION OF THE WORLD.

CAUSES AND METHODS INVOLVED IN THE ENORMOUS INCREASE IN THE PRODUCTION OF GOLD DURING THE PAST DECADE.

L. de Launay—Revue Générale des Sciences.

ALTHOUGH it is known in a general way that the production of gold in all parts of the world has shown a rapid development in recent years. the details of the increase are not readily available in compact form, and hence two papers by M. L. de Launay, an eminent French mining engineer and professor at the Ecole Supérieure des Mines, published in recent issues of the *Revue Générale des Sciences,* demand present attention. M. de Launay treats the subject, first from a statistical point of view, and, second, as a geologist and mining engineer, and some review of both portions of his discussion will be given.

The enormous increase in the rate of the production of gold is one of the remarkable industrial and economic phenomena of the present time. The curves representing the production of other metals have shown upward tendency, more or less marked, but the line showing the gold production of the world shows such a remarkable upward tendency that at times it almost approaches the vertical. When the curve is separated into its three components, representing respectively the three principal sources, the Transvaal, the United States, and Australia, it is seen that there is a marked similarity between them, interrupted only by the break due to the war in South Africa. The figures for the year 1905, as given by M. de Launay, in francs, are: Transvaal 524 millions; Australia, 432 millions; the United States, 436 millions; a total of 1,392 million francs; or about 278 million dollars, or 55 million pounds sterling! These three countries produce 72 per cent. of the world's total, which reaches 1,908 millions of francs, and it is expected that this present year 1906 will see a production of two milliards of francs. An industry which in 1884 produced less than 500 millions, and which, in about twenty years has attained four times that amount, stands, as regards its rate of development, above all other metallurgical industries, iron alone excepted.

The causes for this development are shown by M. de Launay, to be various. Doubtless, the general tendency toward colonial expansion has had a strong influence in the increase in gold mining. The principal cause, however, appears to be an economic one. Apart from the fascination which appears always to have accompanied the mining of gold, there is the all-important fact to the producer of the precious metal that he does not have to seek a market for his product. Apparently there is for it an unlimited market at an unvarying price. This invariability in price is only apparent, since any sudden increase in the production of gold, the accepted monetary standard, would necessarily be accompanied by a corresponding fluctuation in prices. This, however, does not immediately appear, and while the miner does find an immediate market for his product. the economist may consider that which shall occur when the world will be saturated with the metal which is at the same time a commodity and a standard of value. The fact that one nation after another has adopted the single gold monetary standard has undoubtedly stimulated the exploration of all parts of the world, and with the recently developed methods by means of which low grade deposits may be worked to advantage, there is every reason to believe that the production of gold will continue at an increasing rate.

M. de Launay examines the distribution of the gold production of the world in the past, as well as at the present time, showing the recovery of the Transvaal after the Boer war, and the devlopment of the Yukon and the Nome districts in Alaska, together with the revival of gold mining in Mexico.

It is estimated that the total amount of gold produced between 1500 and 1848 in South America, Africa, Russia, and Hungary represented about 15½ milliards of francs. From 1848 to 1889, after the discoveries in California and Australia there was produced 24 milliards, and from 1889 to 1906, since the opening of the Transvaal, about 20.56 milliards, or a total of 60 milliards of francs in gold, or approximately, 17,600 metric tons.

In examining the geological conditions accompany gold mining operations, M. de Launay shows the small proportion of rich deposits, and emphasizes the fact that the production has been closely localized. It has already been stated that the total amount of gold produced from ancient times down to the year 1906 corresponds to only about 17,500 metric tons, with a value of about 60 milliards of francs. Comparing this with the annual weight of iron and steel products, and taking ten hours to a working day, it appears that the total weight of gold in the world is about equal to one hour's product of the iron and steel industries. In speaking of the enormous production of gold at the present time, therefore, the term must be considered only as relative, and used in connection with that of earlier periods.

M. de Launay examines the different conditions under which gold is found, showing its relation to granitic and volcanic rocks, as well as to secondary formations, placers, etc., and proceeds to discuss in a general way the industrial methods for the extraction of gold. These include the earlier appliances for washing the auriferous earth of placer deposits, down to the modern dredge, travelling in a pond of its own excavating, and working deposits too lean to be profitably handled in any other way.

The treatment of free milling ores, the use of the cyanide process, and the chlorination method are also discussed.

It is largely because of the improved process of extraction that the production of gold has increased at the rates already given, since it is by the wholesale application of modern methods that the lowest grade deposits can be commercially worked. Thus, in a large and accessible mine it is assumed, on an average, that the material can be treated for about 12 francs per ton. Very often, however, the cost reaches double this figure, according to location and operative difficulties. In the great workings in Dakota, on the contrary, the cost has fallen as low as 2.10 francs per ton, and at the Alaska Treadwell mine, to the minimum of 1.12 francs.

In the Transvaal, using the cyanide process, the cost of mining and treatment varied from 22 to 80 francs per metric ton, averaging 32 to 35 francs in 1895. Since the Boer war the cost has increased, but it is believed that improvements will cause the expense to be reduced. A portion of the expense in South Africa is due to local causes, and at the Homestake mine, in Dakota, where the cyanide process is also used, the cost does not exceed 8.50 francs per metric ton.

THE ORIGIN AND FORMATION OF COAL FIELDS.

AN EXAMINATION OF THE CONDITIONS SURROUNDING THE CONVERSION OF PRIMEVAL VEGETATION INTO COAL.

James Ford—Iron and Coal Trades Review.

IT is generally understood that the coal fields of to-day owe their origin to the forests of an earlier period in the earth's history, but there are numerous misconceptions as to the conditions under which the change took place. At a recent meeting of the National Association of Colliery Managers, a paper was presented by Mr. James Ford, showing how the formation of coal measures may be traced in existing remains, and from this paper, as published in the *Iron and Coal Trades Review,* we make some extracts. Mr. Ford very properly maintains that it is unnecessary to assume the existence or operation of any other forces and laws in the past than are in action at the present time, believing that it is entirely practicable to explain the formation of coal deposits upon the application of existing conditions.

"It has been quite a common thing in endeavours to account for the existence of such vast masses of vegetation necessary to form the great thickness of our coal seams, to imagine some vast forest growth in quite abnormal climates, and the existence of laws and forces other than at present within the range of man's knowledge; the most prevalent idea being that in a very remote period of the world's history there flourished large forests, the like of which has never been seen in our day, and that these forests sank under the water just as they stood, and, becoming covered over by sediment brought down by water, became changed into a seam of coal. This is quite an erroneous idea, and there is, to my mind, no evidence whatever of any growing forest ever being changed into a seam of coal.

"The supporters of this theory appear to attach great significance to the presence of stigmaria rootlets said to be found in the underclays of the coal seam, and the existence of trunks of the sigillaria tree, and other fossil impressions in close vicinity to the coal, but who has ever discovered any stigmaria roots or a sigillaria trunk in a coal seam? Any traces of roots in the underclays are exceedingly rare, and even then are only grasslike markings which do not in any way affect the distinct parting or parallelism which severs the coal so distinctly from its underclay bed. There is certainly no indication of any plants or trees which may have formed part of the vegetable mass which eventually changed into coal, having roots penetratig into the underclay. I have known of solitary fossil tree trunks with roots attached, and standing erect in or near the coal seam, but these are so rare as to become objects of great interest. They are there by accident, and have had nothing whatever to do with the formation of coal. These trunks have not formed coal at all, but only fossils made up of the small material that formed the roof of the coal seam. They are probably the fossilised remains of solitary trees growing in the vicinity of the area in which the coal vegetation was forming, and are merely incidental and contemporaneous with the period, but were as foreign to the true origin of coal as the overlying roof material. In fact, the most perfect examples of these fossil trees, and the greater number of them, are found in the beds of strata overlying the coal seam and not in the seam itself.

"If it were otherwise, and the vegetation of which the coal is formed consisted of erect timber growing *in situ* in the shape of immense trees having their roots in the underclay, the floor of the seam would necessarily be rough and uneven, because if the trunk of the tree made coal, the butt and the root should do the same, whereas, instead of this added difficulty to mining operations, we have a sharp dividing line with the plane of stratification generally quite smooth. To my mind it is positively certain that the coal vegetation never had roots penetrating into the underclay. The absence of butts or roots in the underclays and the distinct severance of the coal and the underclay is conclusive evidence that no standing timber ever grew there.

"All fossil impressions, whether of trunks of trees, or smaller vegetation such as ferns, mosses, etc., and other organic life belonging to the period, are generally found in the strata lying immediately above the coal seam, and seem to have been conveyed there by the forces which brought the sediment covering the coal seam, and only serve to indicate the kind of flora and fauna of the period. The structure of the coal itself is also opposed to this theory. If we examine a piece of coal, we find its structure is strictly laminated; that is, composed of regular layers which lie parallel to each other, and this parallelism is uniform throughout the whole section, finishing off completely and distinctly where the roof of the seam begins. The parting between the coal and the roof is, in fact, as clean and distinct as the leaves in a book. This arrangement could not have well taken place with standing timber of a mixed growth and uneven size. There would have been irregularity in the laying out of the roof over an irregular growth. Besides, the mixing of the material which formed the roof (which in most cases seems to have been very fine sediment), with the open tops of the standing trees, would have merged the one into the other, and we could not have had such well-defined partings between the roof and the coal as we are all so familiar with."

The microscope gives clear and decisive evidence of the vegetable origin of coal, and we are entirely justified in saying that coal has been formed from the accumulation of vegetable matter which has undergone chemical and physical changes, due to heat, pressure, and chemical action. The real question for investigation is the manner in which the great accumulations of vegetable matter were formed, or, in other words, how the coal *seam* was formed. The best clue to this is a study of the seam itself, as it is found to-day.

A coal seam is generally horizontal, and of fairly uniform thickness and character, with a distinct parting between the seam of coal itself and the roof and floor. In general the floor, or seating is of clay, and the roof of shale or slate, and the appearance of the seams themselves, and the floor and roof, is practically the same in all parts of the world. The appearance of such a seam is almost conclusive evidence that it was not formed directly from a growing forest. Mr. Ford is inclined to think that the action of the microscopic forms of plant life known as the *desmidiaceae* have acted to form vast masses of carbonaceous matter, much in the same manner as diatoms have secreted silica, and other microscopic organisms have produced chalk and coral masses.

"Next to the action of microscopic vegetable life, our nearest analogy to a coal seam is a peat bog, which we can all examine at first hand for ourselves, and which presents almost precisely the same phenomena as our coal seams. Immense swamps, with bottom heat and a moist, warm atmosphere above, and covering hundreds of miles with a rapidly growing mossy vegetation—not at all dependent on the underlying stratum, except that it should be one that held water, and made it comparatively stagnant, such as our underclays would be—would grow feeding on the water alone, with immense rapidity, and filling with their innumerable tissues every space from top to bottom, thus form a mass of solid vegetation with all the conditions favourable and ready for the subsequent changes necessary for its conversion into coal. These bogs of peat can actually be seen growing and forming to-day, ranging in thickness from 20 to 40 feet. They are not by any means rare, and their rate of growth in our day has been observed in different situations to vary from less than a foot to about 2 feet in 10 years. From observations which I was enabled to make on this matter for myself, I found that in a period of from 15 to 20 years a layer of fine vegetable matter, similar to peat, had formed to a thickness of 3 inches from the yearly accumulation of grass seeds alone, in a small depression of the ground, some 60 yards in area. There was a clay bottom, and the sloping sides of the ground were never mown, but were allowed to run wild, and the yearly growth had apparently been washed through the turf in the middle of the hollow and deposited on the clay bed underneath, where it had formed to the thickness I have stated, a pure vegetable deposit.

"From my own observations in this small incident, and the inspection of peat deposits, and from the conclusions of science as to the important part that microscopic creatures have played in piling up vast deposits, I am convinced that the vegetable matter which has gone to the formation of our coal seams has been brought into being in this way. At any rate, the balance of evidence is in favour of this theory, as it will account for all the phenomena we meet with in connection with our coal deposits in a way no other theory will. By this theory we are able to explain satisfactorily the horizontality, the variation in thickness, the existence of the clear, distinct parting at the roof and floor of the mine, and the general uniformity in the structure of the seams. The different thickness of vegetable accumulations would, of course, give a different thickness of coal. The clear partings are accounted for by the fact that the vegetable mass has no roots and no tops; the bottom being simply a material that should hold the water necessary for its growth. The underclays are evidence in support of this. The bands of dirt partings in coal seams are evidences only of a temporary cessation of that particular growth, caused by some terrestrial, or geological, changes with a subsequent return to the former conditions. We are able also to understand how it is that coal is so widely distributed in all parts of the world and in various geological periods, as the only conditions necessary are large sheets of inland water and ordinary atmospheric influences.

"Briefly, then, the coal seams as now found were once vast swampy peat bogs or masses of vegetation forming in immense areas of standing water, accumulating for long periods of time and in favourable climatic conditions, after which the land gently subsided, and the accumulated vegetation became covered over with a layer of mud, or sand brought down by rivers from more elevated places, or an encroachment of the sea; and then as time flowed on, either from the large amount of sediment brought down, or from the gradual uprising of the land, this new surface would again be exposed to the favouring conditions of light and heat, and other harvests of vegetation would grow and accumulate, and they also in turn would become covered over in a similar manner. This phenomenon would occur again and again, and as a matter of fact is still taking place, and thus numbers of coal seams have been formed and brought within man's reach.

WATER-TUBE MARINE BOILERS.

THE REPLACEMENT OF CYLINDRICAL BOILERS BY THE WATER-TUBE CONSTRUCTION IN NAVAL SERVICE.

W. L. Cathcart—Technology Quarterly.

WATER-TUBE boilers have come into very general use for land service, and numerous attempts have been made to design satisfactory marine boilers of this type. The difficult conditions of marine service, however, have led to delays of various kinds, and it is only recently that it had been admitted by marine and naval engineers that the water-tube type of boiler was really adapted for general service at sea. In a lecture delivered before the Naval Architectural Society of the Massachusetts Institute of Technology, Mr. William Ledyard Cathcart, himself a former engineer in the United States Navy, and eminently qualified to discuss this important subject, reviewed the development of the water-tube boiler in marine service, and from his address, as published in the *Technology Quarterly*, we make some notes and abstracts.

Mr. Cathcart maintains at the start that practical experience as well as scientific tests, have demonstrated the unquestionable superiority of the water-tube type for all naval uses, and he predicts that the displacement of the fire-tube type will also be effected for marine service generally. This prediction is based on a careful analysis of the conditions of the generation of steam, and it is from Mr. Cathcart's examination of this part of the question that we make some abstracts.

"There are two stages in the generation of steam: combustion in the furnace and transmission of heat in the boiler proper. The first of these actions is similar in all boilers; in the second there is a marked difference between the fire and water-tube types in this, that in the former the gas currents, after leaving the furnace, are subdivided within tubes which the water surrounds, while in the latter the reverse is the case, the water and steam passing through the tubes. Let us consider the effect of this difference upon heat transmission through heating surface.

"The laws governing such transmission in a boiler of any class are, as a whole, but little known. The final result is the effect of several actions: convection currents and slow internal conduction in the gases, transmission by convection and exterior conduction from gases to metal, internal conduction within the latter and external conduction from it to the water, and, finally, convection currents and feeble internal conduction within the mass of the water or mingled water and steam.

"As to this complex series of operations, there are known only the law of heat transmission through the metal, the conductivity of water and, approximately, that of the gases. The former conductivity is, according to Lord Rayleigh, 115 times less than that of iron, while according to other investigators it is about thirty-five times greater than that of the combustion gases. While this evidence is indirect, it seems clear that heat passes with much greater difficulty from the gases to the metal than from the latter to the water—a deduction which test observations support, since they show always a much greater difference of temperature at the fire side than at the water side of the metal."

The differences in temperature are vital factors in the transmission of heat, and with this difference in temperature must be considered the movement of the water in the boiler—its circulation.

In the older types of cylindrical boiler the circulation was irregular and uncertain, but in the water-tube boiler the circulation is controllable, depending on the arrangement of the tubes. According to the classification of Bertin, the circulation may be: limited, as in the Belleville boiler, corresponding only to the entrance of feed water to replace the evaporation; free, due to slightly inclined tubes, the steam escaping freely from the heating surface by its own motion; and accelerated, in which the tubes are nearly vertical, causing a maximum velocity to be attained, in connection with down-comer pipes for the return flow. The D'Allest boiler is an example of the second type, and the Yarrow, of the third. In general it is believed that a good circulation is essential, and that the efficiency of a boiler, within certain limits, increases with the speed of the circulation.

"Increase in temperature difference gives, *per se,* a rise in heat transmission; but if the results of these two series of experiments be accepted it is clear that at a constant temperature difference a greater velocity of the water augments the rate of heat transmission.

"Boiler economy is, however, dependent, not only upon the efficiency of heat transmission to the water, but also upon that of heat transmission from the gases. Granting that a greater velocity of the water makes possible a higher rate of heat transmission to it, there must be secured, also, a proportionate rise in heat transmission from the gases in order to obtain an increase in boiler efficiency corresponding with that in water speed.

"In discussing these conditions Professor John Perry, F.R.S., said:

"One small tube conveying hot gases, dragged through at an enormous velocity, and a concentric tube conveying water in the opposite direction at great velocity—they had in that combination a method of giving up heat which was fifty times as great as what occurred in an equal amount of heating surface in the best existing boilers.'

"This combination would be, theoretically, most advantageous, especially in its control of the direction and in its minute subdivision of the gas currents, which subdivision would act to offset the low conductivity of the gases. It represents, in effect, the views of Péclet and Rankine carried to what would be a logical but, at present, impracticable extreme.

"The difficulty of effective abstraction of heat from the gases is the limitation which prevents the increase in efficiency otherwise possible by extreme speeds in water circulation. Practically, therefore, all that is necessary is a circulation which is sufficient to sweep away bubbles of steam from the heating surface, thus preventing overheating, which is active enough to keep all water in the boiler at about the same temperature, and which is absolutely free, so that when required the boiler may be forced to the limit fixed by its heating surface, combustion space, and baffling."

If the circulation is sufficiently free, the heat transmission at the water side of the heating surface may be considered as sufficiently rapid to transfer at once all the heat received by the metal, so that the relative efficiency of a boiler depends upon the effectiveness of the heat transmission from the gases. The difficulties to be contended with in this operation are two-fold; being the low conductivity of the gases, and the brief duration of the contact of the gases with the heating surface. The theory of Rankine is that the currents of heated gases and of water should move in opposite directions, but in order to obtain the full benefit of this it is necessary that the mass of the gases should be broken up into sheets sufficiently thin to overcome their low conductivity. This means that effective baffling should be provided, a problem not always easy of solution, especially with some designs of water-tube boilers.

"With regard to heat transmission, any water-tube boiler having a circulation sufficiently free or accelerated is superior to the marine cylindrical type in so far as the water side of the heating surface is concerned, owing to the subdivision of the water within tubes and the active and sustained circulation. As to the gases, however, the reverse is the case in general, since in the cylindrical boiler the total volume of the gases is not only subdivided in tubes, but retarders may be used, as in the Howden system, to combat low conductivity and increase convectional action. Whitham, in trials of a horizontal fire-tube boiler, found that these appliances gave an economic advantage when the boiler was pressed, varying in his tests from 3 to 18 per cent.

"Hence in water-tube boilers generally the heating surface is not, as a whole, as effective as that of the cylindrical type, although portions of it, where the gas circulation is most favorable, are unsurpassed in efficiency A thorough system of baffling, however, in such boilers as are fitted for it overcomes largely the difficulties with regard to the gases."

Mr. Cathcart gives much space to a description of the Babcock & Wilcox water-tube marine boiler, as a form already in extensive use, showing how, in its design, the scientific requirements of marine service have been met, and proceeds to give some examples of the operation of such generators in actual service. One of the special advantages of the water-tube boiler in naval service appears in the ability to raise steam promptly, and data from tests on the *Cincinnati* show what has been done in this direction.

"In the *Cincinnati* tests fires were started on a cold boiler, lightwood being used and the blower running (closed stokehold system). Steam formed in five minutes, and in twelve minutes forty seconds had reached a pressure of 215 pounds gauge. To raise steam in the cylindrical boiler, without special appliances for circulation and without endangering its complex structure, requires from five to ten hours, depending mainly upon whether the boiler is single or double ended.

"Rapidity in raising steam, which is a characteristic of the water-tube boiler in general, is, in navies, of the greatest tactical value. It is a well-known fact that owing to the inherent defect in this respect of the cylindrical boiler the American fleet was, as a whole, unprepared for steaming at full speed when Cervera's squadron made its dash from Santiago. If the ships had been fitted with water-tube boilers the difficult problem which confronted the fleet in maintaining its preparedness for immediate action at full speed would have been solved As it was, banked fires under the full installation required a heavy expenditure of fuel; coaling at sea off Santiago was often impossible, and the retirement of the ship to Santiago for that purpose meant her absence from a possible battle line."

High evaporative performances are now considered as essential in emergencies, involving the employment of forced draft, and Mr. Cathcart gives data and results of tests showing the manner in which the water-tube boiler responds to emergency demands of this sort.

"For full efficiency under forced draught a boiler should have sufficient furnace volume for complete combustion at the maximum rate of coal consumption to be attained; an area of heating surface adequate when fully effective, to lower the temperature of the maximum weight of combustion gases thus produced to that of the normal temperature of the stack; and a system of baffling—either by tube walls or sheet-metal partitions—so designed as to make the whole area of the heating surface effective and to give the greatest possible travel to the gases in their passage from furnace to uptake, while not increasing unduly the draught resistance of the boiler.

"These are the ideal conditions for fully efficient forcing—conditions which the limitations of marine practice make difficult of fulfillment. It is true that large powers have been developed at low air pressures by the high forcing of boilers whose absence of baffling gave them slight draught resistance but the expenditure of fuel per boiler horse power is in such cases correspondingly large, since the gases take the shortest road to the uptake, the entire heating surface is not effective, and the stack temperature is abnormally high."

Mr. Cathcart's paper is an excellent presentation of the present status of the water-tube boiler in marine service, and as such it demands the attention of engineers both in the navy and in the merchant marine.

TECHNICAL WORK IN THE PAST AND PRESENT.

A REVIEW OF THE POSITION AND ACHIEVEMENTS OF THE ENGINEER AND TECHNOLOGIST FROM ANCIENT TIMES TO THE PRESENT.

W. v. Oechelhaeuser—Verein Deutscher Ingenieure.

AMONG the notable papers presented at the Berlin meeting of the Verein Deutscher Ingenieure we note the address of Herr von Oechelhaeuser, both because of its scholarly character, and because it treats of a phase of engineering to which we have made reference more than once of late, his work as an economist and director of human progress. Other eminent writers and speakers have perceived the importance of this phase of human effort, and the address of Reuleaux, "Kultur und Technik," delivered at Vienna more than twenty years ago, may be cited as noteworthy in this respect, but this latest discussion of a subject which can never grow old demands attention at the present time.

That the work of the engineer reaches back into the earliest recorded periods of history is fully understood, and later researches only confirm the work of the earlier investigators. This early engineering work is reviewed by Herr von Oechelhaeuser at length, only to serve for comparison with the progress which has been made in modern times, especially in respect to the well-being of the workers themselves, indebted above all other men for the relief which has been given to them by the engineer.

Passing from ancient times, when massive engineering and architectural works were executed by the main strength of multitudes of workmen, and coming to the last century, the first in which the true development of mechanical technology began to be felt, we may note the extent to which mechanical appliances began to come to the relief of human physical effort.

Thus, in nearly every industry, the more difficult and laborious hand work has been replaced by that of machine tools, and in such work as cannot be wholly performed mechanically, the human portion has been limited to guidance and control, leaving the effort to be done by power. In like manner the mechanical forces of Nature have been placed under control, and improved motors of many kinds have been devised to place natural forces under the control of man. With this control of power there has come a far more efficient utilization of materials than formerly, besides which many by-products are employed to advantage which formerly went to waste. Especially noteworthy has been the improvement in quality and marvellous reduction in cost attained by mass production, involving the development of automatic machinery, repetitive processes, and scientific methods of remuneration of workmen according to their individual productivity.

With these advantages there has come also a greatly improved degree of precision in mechanical operations, a precision carrying with it all the advantages of interchangeability in the product, and a general elevation in the quality of the work of the individual.

Probably no benefit to mankind, due to the work of the engineer, has been greater than the development of facilities for rapid transport, both of himself and his goods from place to place, with a minimum expenditure of time. By this means alone one of the greatest obstacles to progress has been removed, the inability to bring the workman and the work together at moderate expenditure of time and money.

All of these elementary advantages unite to produce social and commercial developments impossible under earlier conditions. The substitution of mechanical for human energy has made possible the association of capital for the conduct of undertakings altogether impracticable to subdivided effort, while many results absolutely impossible to the unaided effort of man have been readily accomplished by the association of natural resources under human guidance.

An excellent example of what has been accomplished by the development of applied science is seen in Germany alone, when it is realised that the population of the empire has grown from 35 millions in 1850 to 60 millions in 1905, while the latter population is housed and fed and provided for, within the same area, in far greater comfort and happiness than was possible for the smaller number at the earlier date.

When to this evidence of progress there is added the fact that during this same period the German empire has added to its standing army from 800,000 to 900,000 men, drawn from productive service, and necessarily supported by the balance of the working population, it will be realized how effectively improved methods and appliances have added to the productive efforts, both of mechanics and agriculturists, or, as Herr von Oechelhaueser says: "given an increased motive power to the nation."

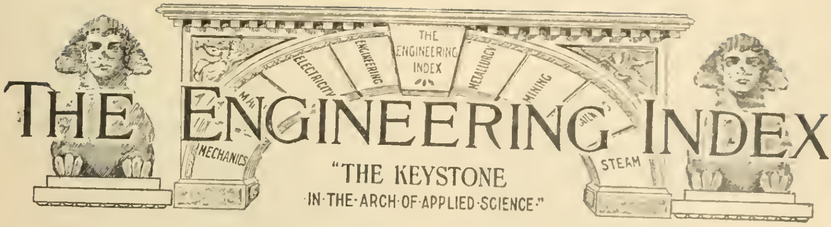
Herr von Oechelhaueser reviews in detail the improvements in technical methods and appliances which has thus so greatly increased the earning and productive capacity of the workman, including the development of automatic machinery, the introduction of milling cutters, of standard tools, improved motors, and the like. To these must be added the tremendous changes wrought by the commercial introduction of electricity for power, light, and communication, enabling the tool to be brought to the work, and the motive power to be delivered anywhere where a wire can be run. All of these, and many other improvements, have themselves created new industrial opportunities, the new appliances and methods requiring workshops for their manufacture, and creating commerce for their distribution, so that the growth has been like that of the snowball, increasing by the accretion of its own progress.

All these things we perceive have acted to increase the productiveness and wealth of a nation, but there is a further question to be asked: "What about the man?"

Has the development in applied science raised him to a higher plane of living, or has it acted to make him more and more of a machine himself?

Herr von Oechelhaueser protests strongly against the opinion which would make us believe that this material progress has been accomplished at the cost of a degradation of the worker from whose efforts the production must come. To him it clearly appears that the reaping machine has not debased the farmer, the sewing machine has not lowered the operative below the older hand worker, the machine tool degraded the mechanic. Surely the modern motorman, or the skilled chauffeur is higher in grade than the cabby, and the electrician in a superior class than the old-time lamplighter. In other departments of everyday life we may look for examples, and in so doing care should be taken to compare the present condition of life with that of the workers who formerly did the corresponding service, and few instances will be found in which the man has not been elevated with the progress which has been made in his work.

Turning to another side of material progress, Herr von Oechelhaueser shows how the power of modern capital is largely due to technical progress. Without the methods due to modern applied science neither the aggregations of capital necessary for modern undertakings could be provided, nor, when gathered, could they be utilised to advantage. With capital, and with mechanical appliances must come also modern technical education, enabling further progress to be made, in an ever widening field, not only in Germany, but throughout the world.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Concrete Arch Bridge on the Queensland State Railways, Degilbo, Queensland. Illustrated description of a concrete arch of 80-ft. span across Deep Creek. 400 w. Eng News—July 19, 1906. No. 78065.

Concrete Arch on the Big Four at Danville. Illustrations taken during construction and after completion of this interesting reinforced concrete bridge, with information. 700 w. R R Gaz—July 13, 1906. No. 77946.

Thickness of the Key in Masonry Arches (Epaisseur à la Clef des Voutes en Maçonnerie). M. Davidesco. Deriving a new formula, adapted to arches of any form, for computing the thickness of the keystone. 2500 w. Ann d Ponts et Chaussées—1 Trimestre, 1906. No. 78136 E + F.

Bay of Fundy

Engulfing a Waterfall. Illustrated description of natural wonders at the Bay of Fundy, and two bridges crossing the St. John river at St. John, New Brunswick. 1400 w. Ry & Loc Engng—July, 1906. No. 77862 C.

Cantilever.

Cantilever Bridge of 1800 ft. Span Across the St. Lawrence. Illustrations, with brief description of details of the Quebec bridge. 450 w. Engng—July 6, 1906. No. 77981 A.

Drawbridges.

Replacing the Broadway Drawbridge with a New Span. Describes and illustrates interesting engineering methods used in transferring the old Broadway drawbridge over the Harlem ship canal to its new position, and the subsequent placing of the new span, made necessary to accommodate an extension of the Subway across the Harlem River. 700 w. Sci Am—June 30, 1906. No. 77709.

The Motive Power Arrangements of the New Railway Bridge over the North-Sea Canal at Velsen (Die Bewegungseinrichtungen des Neuen Eisenbahnbrücke über den Nordsee-Kanal bei Velsen). J. J. W. van Loenen-Martinet & F. C. Dufour. The bridge spans the Amsterdam-North Sea Canal for the railway between Haarlem and North Holland. The paper discusses the electric power arrangements for operating the large draw. 4000 w. Zeitsche d Ver Deutscher Ing—June 30, 1906. No. 78106 D.

Floors.

Tests of Metal Floors (Epreuves des Tabliers Métalliques). M. Garau. Data and results of tests of the floors of bridges on the railway between Quillan and Rivesaltes, in the French Pyrenees. 10000 w. 4 plates. Ann d Ponts et Chaussées—1 Trimestre, 1906. No. 78,-134 E + F.

Girders.

The Most Efficient Depth of Parallel Girders (Beitrag zur Theorie der Gunstigsten Trägerhohe des Parallelträgers). F. Gebauer. A mathematical examination of the strength of lattice girders, deriving formulas for the most efficient distance between chords. Three articles. 10000 w. Zeitschr d Oesterr Ing u Arch Ver—June 29, July 6, 13, 1906. No. 78159 each D.

Liege.

The Bridge of Commerce, Liège. Illustrated description of the new bridge over the river Meuse. 3000 w. Engr, Lond—July 20, 1906. No. 78315 A.

Model.

The Construction of a Bridge Model. Jarvis A. Marikle. Half-tones and description of a model of a portion of a double track cantilever bridge, at Pittsburg. 2000 w. Mach, N Y—July, 1906. No. 77700 C.

Reconstruction.

The Reconstruction of the Susquehanna River Bridge. An illustrated description of the methods used in replacing a single track bridge at Brown's, Pa., by a double-track plate-girder. The method of erection was novel and interesting, designed to suit the difficult conditions. 2500 w. Eng Rec—July 28, 1906. No. 78276.

Reinforced Concrete.

Jefferson Street Bridge, South Bend, Ind. Illustrates and describes a reinforced-concrete monumental arch bridge, having a total length of 554 ft. 4000 w. Eng Rec—July 28, 1906. No. 78273.

Reinforced Concrete Bridge on East Washington Street, Indianapolis, Ind. D. B. Luten. Illustrated description of an arch bridge reinforced wholly with smooth steel rods, and its method of construction. 1500 w. Munic Engng—July, 1906. No. 78036 C.

Strengthening.

The Strengthening of the La Canche Viaduct (Consolidation du Viaduc de la Canche). M. Lefebvre. Describing the manner in which an old masonry viaduct was strengthened by injecting liquid cement into the stone work. 3000 w. 1 Plate. Ann d Ponts et Chaussées—1 Trimestre, 1906. No. 78135 E + F.

Suspension.

Suspension Bridges and Arches (Ponts Suspendus et Ponts en Arc). E. Lebert. A comparison of the formulas of Godard and of Levy, considering suspension bridges and arches, each as an inversion of the other. 10000 w. Ann d Ponts et Chaussées—1 Trimestre, 1906. No. 78,-129 E + F.

Viaduct.

The Rondout Viaduct on the West Shore Railroad. Part elevations and plans with detailed description of the double-track structure recently built to replace a lighter superstructure. 2500 w. Eng Rec—July 14, 1906. No. 77939.

CONSTRUCTION.

Abattoir.

A Model Fireproof Abattoir. Illustrates and describes the fireproof and sanitary plant of the New York Butchers' Dressed Meat Co. 2000 w. Ins Engng—July, 1906. No. 78243 C.

A Model New Abattoir in New York City. Illustrated description of the new plant of the New York Butchers' Dressed Meat Co., located at Eleventh Ave. and 39th St., and the sanitary conditions adopted. 5000 w. Eng Rec—June 30, 1906. No. 77719.

Construction Features of a Model Abattoir. Illustrates and describes the design and construction of the buildings of the New York Butchers' Dressed Meat Co., in New York City. 3800 w. Eng Rec—July 7, 1906. No. 77834.

Model Municipal Slaughtering Establishment at Berlin—A Lesson in Sanitary Meat Dressing. William Mayner. Illustrations of the buildings, and description of the methods employed. 1600 w. Sci Am—July 28, 1906. No. 78269.

Power Plant of the New Abattoir in New York City. An illustrated detailed description of a 1600 h.p. boiler plant, with extensive coal storage facilities, an electric generating equipment of an aggregate capacity of 1000 kw. and refrigerating machinery with a total capacity of 250 tons of refrigeration per 24 hrs. 4000 w. Eng Rec—July 21, 1906. No. 78077.

Bins.

Investigations upon the Bottom and Lateral Pressures in Grain Storage Bins (Versuche zur Ermittlung der Boden und Seitenwanddrücke in Getreidesilos). J. Pleissner. Experimental determinations of the actual vertical and lateral pressures in bins of wood and of reinforced concrete. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—June 23, 30, 1906. No. 78104 each D.

Caisson Disease.

Investigations of the Effect on Man of High Air Pressures. Notes from a paper before the Royal Society, reporting the experiments and conclusions of Dr. Hill and Dr. M. Greenwood, Jr. 2200 w. Eng Rec—June 30, 1906. No. 77722.

Fireproof.

Developing Fireproof Architecture. George E. Walsh. Shows the effect of recent changes of building construction upon fireproof clay products, and the importance of furnishing good materials. 2500 w. Brick—July, 1906. No. 77901.

Foundations.

A Concrete Foundation. J. Mayne Baltimore. Illustrates and describes how one of the most dangerous rocks of the California coast was converted into a foundation for a lighthouse by the use of concrete. 600 w. Cement Age—July, 1906. No. 77861.

Footings in Foundations. Wilfrid Joseph Dilley. An investigation made to determine the slope for varying conditions. 1500 w. Inst of Civ Engrs—No. 3572. No. 78021 N.

The Foundation of the Myers Building, Albany. Illustrated description of methods used in reconstructing this department store, and the bracing and underpinning of adjacent buildings. 3300 w. Eng Rec—June 30, 1906. No. 77726.

Some Foundations for Buildings in Cleveland. Gen. J. A. Smith. Reviews successful past-foundation work in Cleveland and protests against the change to pile foundations for heavy buildings. General discussion. 14000 w. Jour Assn of Engng Soc—April, 1906. No. 78238 C.

Lighthouse.

The Construction of a Tower in Cement Concrete (La Construction d'une Tour en Béton de Ciment). M. Alexandre. Detailed description of the erection of a concrete lighthouse tower 64 metres high, at the Pointe de la Coubre, at the mouth of the Gironde, France. 7500 w. 2 plates. Ann d Ponts et Chaussées—1 Trimestre, 1906. No 78128 E + F.

Office Buildings.

Reinforced Concrete Bank and Office Building, Los Angeles, Cal. Max J. Welch. Illustrates this recently completed building, discussing the engineering details of the construction. 1000 w. Eng News—July 5, 1906. No. 77821.

The Design, Installation and Maintenance of the Modern Office Building. Charles Gobrecht Darrach. A review of the design, construction and of the mechanical installations required to meet the necessities of these business centers. Ills. 6000 w. Jour Fr Inst—July, 1906. No. 78010 D.

The United States Express Co.'s Building, New York City. Illustrated detailed description of a 22-story, basement and cellar building on Rector & Greenwich Sts., New York City. Especial care was given to the provisions for wind pressure. 3000 w Eng Rec—July 28, 1906. No 78277.

Piles.

Concrete as Piling. Frank B. Gilbreth. Read at meeting of Am. Portland Cement Mfrs. Illustrated description of the making and driving of corrugated concrete piles. 1600 w. Cement Age—July, 1906. No. 77860.

Reinforced Concrete.

Ferro Concrete. H Kestner Read at meeting of the Inst. of Mech. Engrs., Johannesburg. Discusses the qualities which give this material advantages as compared with ordinary constructions, and the precautions necessary to secure satisfactory results. 5000 w. Archt, Lond—June 22. 1906. No. 77772 A.

Reinforced Concrete in the New San Francisco Building Law. Gives the portions of the new building law relating to buildings with self-supporting walls and metal frames carrying the floors only. 1800 w Eng News—July 26, 1906. No. 78235.

Results of Plain and Reinforced Concrete Column Tests at Watertown Arsenal. James E. Howard. Read at meeting of the Am. Soc. for Test. Mat. Diagrams, and discussion of certain features of tests in progress, tending to show that high ultimate strength may be reached by each of the three methods considered 1600 w. Eng News—July 5, 1906. No. 77823.

The Adhesion of Concrete to Steel. Editorial on the investigations and results for the purpose of ascertaining values of the adhesion between concrete and embedded bars of iron and steel. 1700 w. Builder—June 30, 1906. No. 77872 A.

The Comparative Advantages of Hard and Soft Steel for Reinforced Concrete. Daniel B. Luten. Presents the arguments given by both sides and concludes that neither presents any marked advantage over the other for reinforcement. 2300 w. Eng News—July 19, 1906. No. 78068.

The Design of Reinforced Concrete Columns and Footings. Edward Godfrey. Supplementing an earlier paper on the "Design of Reinforced Concrete Beams and Slabs." 3000 w. Eng News —July 12, 1906. No. 77925.

The Determination of the Best Proportions for Reinforced-Concrete Beams (Die Bestimmung der Wirtschaftlich Günstigsten Abmessungen von Eisenbetonbalken). R. Saliger. An examination of beams, reinforced for tension and for compression stresses, with tables for practical computation. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 7, 1906. No. 78161 D.

See Also Civil Engineering, Bridges.

Retaining Walls.

Masonry Retaining Walls (Murs de Sontènement en Maçonnerie). F. Chaudy. Describing a peculiar form of retaining wall, with spurs or projections of reinforced concrete extending back into the earth behind. 2000 w. Mem Soc Ing Civ de France—March, 1906. No. 78138 G.

Roads.

Experiments with Tar and Oil for Roads at Jackson, Tenn. Describes methods used and excellent results obtained with tar, giving the cost. Also the results obtained with oils and the cost. 2800 w. Eng Rec—June 30, 1906. No. 77725.

Roofs.

A Practical Talk on Roofing. Discusses how to put on good tin roofs, the conditions, workmanship, etc. Ills. 2800 w. Met Work—July 14, 1906. No. 77902.

The Charing Cross Roof. Remarks about the cause of the accident as given in the report of Major J. W. Pringle. 2200 w. Archt, Lond—June 22, 1906. No. 77773 A.

The Disaster at Charing Cross Railway Station. A review of Major Pringle's report to the Board of Trade concerning the fall of roof and its causes. Ills. 2200 w. Ir & Coal Trds Rev—June 22, 1906. No. 77791 A.

Steel Details.

Some Steel Details in the Wanamaker Building, New York. Outline description of this building, with special notes on the framing. 1200 w. Eng Rec—June 30, 1906. No. 77721.

Tunnels.

Construction Difficulties with the Bosruck Tunnel (Die Bauschweirigkeiten beim Bosrucktunnel), M. J. Blodnig. A general illustrated account of the work on the tunnel under the Bosruck from Ardning to Emiliendorf, in the Styrian Alps. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—June 22, 1906. No. 78158 D.

Lowering the Tunnels Under the Chicago River. Concerning the lowering of the three street railway tunnels under the Chicago River, and the methods proposed. Editorial explaining the necessity of the work and the advantages to be gained. 2000 w. Eng Rec—July 21, 1906. No. 78078.

Single and Double Track Alpine Tunnels (Einspurige und Zweispurige Alpentunnel). Prof. Hennings. Describing a plan for boring a double track tunnel, with a small tunnel beneath for construction and ventilation. 1800 w. Schweiz Bauzeitung—June 16, 1906. No. 78141 B.

The Construction of the East River Division of the Pennsylvania, New York and Long Island Railroad Company's Tunnels. Begins a full account of the work as it now stands, the difficulties met, etc. Also editorial. Ills. 4800 w. Eng Rec—July 14, 1906. Serial. 1st part. No. 77934.

The East River Tunnels for the New York City Terminus of the Pennsylvania and Long Island Railroads. Describes interesting features of the construction work. 2300 w. Eng Rec—July 7, 1906. No. 77836.

The Pennsylvania Tunnels Under the East River. A brief description of the methods employed in driving the tunnels and the working plant of the contractors. Ills. 7000 w. R R Gaz—July 6, 1906. Serial. 1st part. No. 77813.

The Simplon Tunnel (Le Tunnel du Simplon). E. Lemaire. A well illustrated account of the design and execution of the Simplon tunnel, and a comparison of its facilities with those of the other Alpine tunnels. Two articles, 7500 w. 1 plate. Génie Civil—June 23, 30, 1906. No. 78122 each D.

The Simplon Tunnel (Per l'Apertura del Sempione). Gustavo Coen. A review of the new commercial routes rendered available by the completion of the new route through the Alps. Two articles, 12,000 w. Rivista Marittima—April, May, 1906. No. 78185 each H.

The Tunnel Work of the Pennsylvania Railroad Under the East River. Concerning the construction of the two twin-tube shield-driven tunnels, the compressed air work, shaft construction, shield construction, etc. 3800 w. Eng News—July 12, 1906. No. 77929.

Tunneling by the Freezing Method Under the East River. An account of an experiment in progress by the Pennsylvania R. R. with a new system of freezing the moist material so that no air pressure will be require. 1600 w. Sci Am—July 14, 1906. No. 77930.

Working of the Simplon Tunnel. Notes on the tunnel and its approach lines, the ventilation, temperature, etc. 1500 w. Engr, Lond—June 22, 1906. No. 77797 A.

Underpinning.

Underpinning a Tall Brewery Wall on Rock Foundations. A brewery on Park Ave., New York City, jeopardized by the terminal improvements of the N. Y. C. & H. R. R. R., is described and the method of underpinning explained and illustrated. 1800 w. Eng Rec—July 7, 1906. No. 77839.

Underpinning the Grand Central Palace, New York. Illustrated description of methods used in underpinning a heavy wall of old-fashioned construction in connection with the construction work of the depressed yards of the N. Y. C. & H. R. R. R. Also editorial. 2800 w. Eng Rec—June 30, 1906. No. 77723.

MATERIALS OF CONSTRUCTION.

Asphalt.

The Proximate Composition and Physical Structure of Trinidad Asphalt. Clifford Richardson. Reports investigations carried out to determine the character of the substances which make up the portion of refined asphalt hitherto regarded as "organic matter not bitumen." 3500 w. Eng Rec—June 30, 1906. No. 77727.

Brick.

A Large Shale Brick Factory in Eastern Illinois. Illustrates and describes a plant at Danville, Ill., which has a capacity of producing 200,000 bricks a day. 3000 w. Eng Rec—July 7, 1906. No. 77838.

New Sand-Lime Brick Plant at South River, N. J. A plant for the manufacture of sand-lime brick under the Huennekes system is illustrated and described. 2700 w. Eng Rec—July 14, 1906. No. 77938.

Building Stones.

Tests of Building Stones. Valuable data on the fire resistance of natural building stones found in New York State. Ills. 3300 w. Ins Engng—July, 1906. No. 78245 C.

Cement.

A Talk on Cement. An article based on an account by P. Gillespie, in the report of the Bureau of Mines of Ontario, Vol XIV. Its chemical composition and uses are discussed in the present number. 1200 w. Can Archt—June, 1906. Serial. 1st part. No. 77714 C.

Cement Testing Laboratory, Philadelphia Rapid Transit Company. Gives the specifications for Portland cement as adopted, and describes the tests, and other work done in the laboratory. 2200 w. Ry Age—July 27, 1906. No. 78290.

The Manufacture of Portland Cement. On the processes of cement-making as carried on at the Northfleet Works of the Associated Portland Cement-Manufacturers, Limited. Ills. 4000 w. Engng—July 20, 1906. No. 78308 A.

Concrete.

Proportioning Concrete. Sanford E. Thompson. Considers methods of proportioning materials and for comparisons of quality, and the effect of different characters of aggregate. General discussion. 5800 w. Jour Assn of Engng Socs—April, 1906. No. 78239 C.

The Action of Sea Water Upon Concrete. J. Watt Sandeman. Discusses proposed standard proportions for impervious concrete, giving tables estimating cost, etc. 1400 w. Sci Am Sup—June 30, 1906. No. 77711.

The Puddling Effect of Water Flowing Through Concrete. William Ralph Baldwin-Wiseman. Gives results of experiments on the rate of flow of water through a specimen of concrete, identical in composition with that used in the construction of the new graving-rock at Southampton. 1200 w. Inst of Civ Engrs—No. 3574. No. 78022 N.

Laboratory.

The Underwriters' Laboratory Plant in Chicago. Illustrated detailed description of this building which is devoted exclusively to experimental work in fire protection engineering. 2700 w. Eng Rec—July 7, 1906. No. 77833.

Protective Coatings.

Protective Coatings for Iron and Steel. Arthur B. Harrison. Read before the Am. Soc. for Test. Mat. Reviews the opinions of those who have made a study of this subject, and reports experiments and results. Favors the use of carbon coatings which dry by evaporation. 3000 w. Eng Rec—July 7, 1906. No. 77835.

Testing.

Influence of the Temperature of Water upon Test Pieces (Influence de la Temperature de l'Eau sur les Eprouvettes). M. Mercier. Data and results of investigations upon the influence of the temperature of the water on cement and mortar briquettes. 2500 w. Ann d Ponts et Chaussées—I Trimestre, 1906. No. 78132 E & F.

Tension-Tests of Steel Angles with Various Types of End-Connection. Frank P. McKibben. Read before the Am. Soc.

for Test. Mat. An account of tests made in the testing laboratory of the Mass. Inst. of Technology upon 27 specimens of rolled steel angles such as are used in structural work. 1200 w. Eng News—July 5, 1906. No. 77820.

The Sand Blast for Testing Materials. H. Burchartz. Illustrates and describes the apparatus used in applying the sand blast to the testing of materials for building, paving, etc. 1200 w. Eng Rec—July 14, 1906. No. 77936.

MEASUREMENT.

Photogrammetry.

The Use of Tentative Photography in the German Navy for Exploration Work (Sur Plusieurs Tentatives Poursuivres dans la Marine Allemande pour Utiliser la Photographie dans les Voyages d'Exploration). A. Laussedat. A discussion of the work of Laas, in measuring ocean waves on the Preussen, comparing the method of intersections with the method of parallaxes. 2500 w. Comptes Rendus—June 11, 1906. No. 78124 D.

Seismographs.

Earthquake Records and Their Interpretation. Gives an actual record of an earthquake showing some of the irregularities, with explanation. 2000 w. Engng—June 29, 1906. No. 77891 A.

Seismograph and Magnetograph Records of the San Francisco Earthquake, April 18, 1906. Dr. L. A. Bauer. A study of seismograph and magnetograph records, and of why an earthquake will at times be recorded by magnetic instruments, and at other times leave no record. 4000 w. Pop Sci M—Aug. 1906. No. 78257 C.

The Investigation of the San Francisco Earthquake. G. K. Gilbert. An illustrated sketch of the physical features of the California earthquake, with explanation of the causes. 5000 w. Pop Sci M—Aug, 1906. No. 78256 C.

Surveying.

Azimuth Circles with Microscopes for Surveying Work (Cercle Azimutal du Service Technique du Cadastre). Ch. Lallemand. Describing an improved type of theodolite of a high degree of precision, with tests by the Ponts et Chaussées. 1000 w. Comptes Rendus—June 5, 1906. No. 78127 D.

Surveying Without Instruments. A. L. de Leeuw. Explains how work of sufficient accuracy for many cases may be done without the ordinary surveyor's instruments. Gives examples. 2000 w. Mach, N Y—July, 1906. No. 77703 C.

MUNICIPAL.

Dust.

The Suppression of Dust on Roads by Oil Sprinkling. An account of method, cost, etc., of this treatment of streets and roads as carried out at North Sydney, N. S. W. 1500 w. Engng—July 13, 1906. No. 78218 A.

Fire Protection.

Fire Protection in Cities. S. H. Lockett. Discussing the development of water-works systems and public fire departments in American cities. 6000 w. Ins Engng—July, 1906. No. 78244 C.

Parks.

The Preservation of Open Spaces in Large Cities (La Conservation des Espaces Libres dans les Grandes Villes). A. Bidault des Chaumes. A discussion of the importance of municipal parks, with illustrations from Paris, London, Berlin, and other cities. 3000 w. Génie Civil—June 16, 1906. No. 78121 D.

Sanitation.

Experimental Methods as Applied to Water and Sewage-Works for Large Communities. George W. Fuller. One of several papers prepared in commemoration of the twenty-fifth anniversary of the doctorate of Prof. William T. Sedgwick. Discusses sanitary science, the new conditions, and methods being tried to meet their requirements. 6000 w. Eng Rec—July 21, 1906. No. 78079.

Sanitary Science and the Public Health. Leonard P. Kinnicutt. Commencement lecture. Especially considering modern methods of sewage disposal. Ills. 4000 w. Jour Worcester Poly Inst—July, 1906. No. 78004 C.

Sewage.

Report of the Board of Advisory Engineers of the Sewerage Commission of Baltimore. A report of the conclusions reached in regard to the problem of sewage treatment with the object of obtaining "the highest practicable degree of purity." 6000 w. Map. Eng Rec—July 28, 1906. Serial. 1st part. No. 78275.

The Operation of Sewerage Works. A number of papers by different writers, reporting the systems in use at various places, mostly isolated plants for schools, colleges, sanatoriums, etc. Ills. 5800 w. Jour Assn of Engng Socs—April, 1906. No. 78237 C.

The Purification of Sewage and Industrial Wastes (Epuration des Eaux d'Egout et des Eaux industrielles). B. Bezault. A review of the bacterial process of sewage purification, with examples from British and French installations. 10,000 w. Bull Soc d'Encour—May 31, 1906. No. 78174 G.

The Purification of Waste Water (Epuration des Eaux Usées). M. Michel. An exhaustive review, historical and technical of the development of modern methods of sewage purification, with especial reference to bacterial processes in France. Serial, Part I. 15,000 w. Ann d Ponts et Chaussées—I Trimestre, 1906. No. 78130 E + F.

Sewers.

Practical Sewerage. Alberto F. Schreiner. A general description of the method of designing sewerage systems and the method of construction of sewers used in the Bureau of Sewers of the Borough of Queens, New York City. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1906. No. 78038 G.

Streets.

Adjourned Discussion on Mr. Waterhouse's Paper: "Some Observations on the Report of the Royal Commission on London Traffic, with Special Reference to the Proposed Formation of New Thoroughfares." 10500 w. Jour Roy Inst of British Archts—June 16, 1906. No. 77840 C.

An Important Street Improvement with Street Railway Subway at London, England. Cross-sections and description of a broad thoroughfare running north from the Strand; and of the shallow subway for double-truck cars. 2000 w. Eng News—July 12, 1906. No. 77927.

Street Extensions in Queens Borough, New York City. Albert H. Chandler. An account of the work of the Topographical Bureau, their methods, etc. 4200 w. Trans Assn of Civ Engrs of Cornell Univ—1906. No. 78039 G.

WATER SUPPLY.

Air-Lift.

On the Raising of Water by Compressed Air, at Preesall, Lancashire. James Kelly. Describes experiments carried out at works requiring 800,000 gallons of water every 24 hours. 5000 w. Inst of Civ Engrs—No. 3573. No. 78025 N.

Boring.

The Deep Well and Boring at Lincoln. An account of the deepest boring in the United Kingdom, and the great find of water. Also editorial. 2500 w. Jour Gas Lgt—June 19, 1906. No. 77774 A.

Boston.

The Water Supply of Boston. An illustrated review of the history of water supply for Boston, Mass., dating back to 1652. 2000 w. Fire & Water—July 7, 1906. No. 77800.

Cincinnati.

Water Famine and Typhoid in Cincinnati. Ward Baldwin. An explanation of the causes of the so-called "water famine" which occurred in certain parts of Cincinnati during the week June 3, to 10 of this year. Maps. 2000 w. Eng News—July 5, 1906. No. 77819.

Filtration.

Springfield's New Filters. Elbert E. Lockridge. Describes sand variety filters for clarifying water highly polluted with anabaena, and gives an account of the difficulties overcome. 2700 w. Munic Jour & Engr—July 4, 1906. No. 77805 C.

The Sand Filtration of Potable Water (La Filtration sur Sable des Eaux Potables). A. Bidault des Chaumes. A description of the Puech system of sedimentation as installed at Nanterre, Mont Valerien, for the supply of the suburbs of Paris. 2500 w. 1 plate. Génie Civil—May 26, 1906. No. 78117 D.

Gates.

The Balanced Gates at the Crotoy Reservoir (Vannes Equilibrées du Crotoy). M. Chevallier. Describing the installation of balanced gates of the Stoney type in the regulating reservoirs of the Somme. 2500 w. 1 plate. Ann d Ponts et Chaussees—I Trimestre, 1906. No. 78137 E + F.

Ontario.

The Water-Works of St. Catharines. Alexander Milne. An illustrated descriptive and historical review of the supply for this city, near Niagara Falls. 2000 w. Fire & Water—July 7, 1906. No. 77802.

Pumping.

The Growth of the Pumping Station. Charles A. Hague. Read before the Am. Water-Works Assn. A review of the growth and development of pumping stations, and the tendency for future construction and operation. 7000 w. Eng Rec—July 14, 1906. No. 77940.

Purification.

Disinfection as a Means of Water Purification. George C. Whipple. Read before the Am. Water-Wks. Assn. Calls attention to the need of more thorough study of this subject, and describes the water-works of Ostende and Middelkerke, Belgium, where chlorine is used as a disinfecting adjunct to filtration. 4000 w. Eng Rec—July 28, 1906. No. 78274.

Reclamation.

The United States Reclamation Service. An explanation of the methods of carrying on the work of irrigation in the western part of the United States. 2300 w. Engr, Lond—July 6, 1906. No. 77988 A.

Regulations.

Regulations Governing the Submission of Water Supply Projects for the Approval of the Prussian Government. Translated by William Paul Gerhard. A copy of a circular published by the Prussian Minister for Education and Sanitary Matters. 2200 w. Eng News—July 19, 1906. No. 78066.

Reservoirs.

The Emptying of Systems of Reservoirs (Le Vidage des Systèmes de Réservoirs). Edmond Maillet. A mathematical study of the time required to empty reservoirs situated at various levels and with communicating pipes in different positions. Formulas are derived for the more general cases. 9000 w. Ann d Ponts et Chaussées—1 Trimestre, 1906. No. 78131 E + F.

WATERWAYS AND HARBORS.

Canal Lifts.

Elevators for Canal Boats (Ueber Schiffshebewerke). Dr. A. Riedler. A comparison of the inclined plane and the revolving drum design as submitted in the competition for the Danube-Oder canal, at Prerau. Serial, Part I. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—July 13, 1906. No. 78160 D.

Canals.

An Underflow Canal Used for Irrigation at Ogalalla, Nebraska. Charles S. Slichter. Describes one of the most successful underflow canals, discussing the causes of failure of this method of irrigation. Ills. 2200 w. Eng News—July 5, 1906. No. 77817.

On Waterways in Great Britain. John Arthus Saner. Considers the present condition of the waterways and the measures necessary for their improvement. Tabulated information is given in appendixes, also discussion. Maps. 50000 w. Inst of Civ Engrs, No. 3593—Nov. 14, 1905. No. 78017 N.

Docks.

Lowering the Sill of the Great Central Railway Union Dock, Grimsby. An illustrated description of the methods adopted, which allowed shipping to pass in and out of the dock. 2000 w. Engng—July 20, 1906. No. 78311 A.

The Chalmette Docks of the New Orleans Terminal Co. Illustrated description of this immense deep-water railroad and ship terminal on the Mississippi River at New Orleans. 5000 w. Eng Rec—July 28, 1906. Serial. 1st part. Also editorial. No. 78272.

Dredging.

A New Dredging Vessel for India. Illustrated description of the suction-pump canal embanking dredger Foyers, built for the government of India. 800 w. Marine Rev—July 12, 1906. No. 77952.

Dredging Plant for India. Illustrated detailed description of a large and notable dredging vessel for special work in the Bengal Presidency. It is a suction-pump, triple-screw, canal embankment dredger designed especially for opening new waterways, and improving shallow canals and rivers. 1200 w. Engr, Lond—July 13, 1906. No. 78222 A.

Harbors.

The Port of San Pedro. An illustrated account of the development of this port of southern California, with explanation of the causes that have effected its improvement. 2200 w. Marine Rev—July 26, 1906. No. 78271.

Lock.

The Construction of a Second Tide Lock in the Merwede Canal at Utrecht (Over den Bouw eener Tweede Schutsluis in het Merwede Kanael bewesten Utrecht). A. E. Kempees. With plans of the lock and details of the foundations and photographs of construction work. 2500 w. De Ingenieur—July 7, 1906. No. 78182 D.

Pier.

Reconstruction of the Atlantic City "Steel Pier" in Reinforced Concrete. An illustrated article describing the plan of construction, and rebuilding. 2500 w. Eng News—July 26, 1906. No. 78233.

Storage and Shipment of Iron Ore at Almeria. John Ernest Harrison. An illustrated description of the Alquife Co.'s pier in the south of Spain, and the appliances for the shipment of hematite ore. 3300 w. Inst of Civ Engrs—No. 3564. No. 78020 N.

River Regulation.

Regulating Dams for the San Juan and Mendoza, Argentina (Diques Niveladores de San Juan y Mendoza). Oreste Vulpiani. A report to the government, showing the importance of rebuilding the regulating dam on the San Juan, in a manner similar to that already done on the Mendoza. 4000 w. La Ingenieria—May 15, 1906. No. 78183 D.

Thames.

The Thames Conservancy. Describing the work of improving and deepening the navigable channel which is in progress and proposed. 1700 w. Engr, Lond—July 20, 1906. Serial. 1st part. No. 78318 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Submarine Cables. H. C. Specht. Describes the construction, laying and repair of a modern submarine cable. Ills. Discussion. 4000 w. Pro Engrs' Soc of W Penn—July, 1906. No. 78246 D.

Space Telegraphy.

A Note on the Theory of Directive Antennæ or Unsymmetrical Hertzian Oscillators. J. A. Fleming. Read before the Royal Soc. Gives a mathematical explanation of the fact that a bent oscillator radiates more in the direction opposite to that in which the free ends point than it does in the other direction. 1700 w. Elect'n, Lond—July 6, 1906. No. 77971 A.

Interference in Wireless Telegraphy and the International Telegraph Conference. R. A. Fessenden. Deals with the subject of selective receptions of wireless telegraph messages. 2200 w. Elec Rev, Lond—July 6, 1906. Serial. 1st part. No. 77969 A.

Wanted: A Synthetic Wireless. B. T. Walling. Discusses the present outlook for a satisfactory synthetic system, giving a report of tests made at Culebra, and considering some effects of synthesis. 3500 w. Pro U S Nav Inst—June, 1906. No. 78031 G.

Wireless Telegraphy. H. M. Hozier. A sketch of the position of wireless telegraphy in the United Kingdom, and the movement to place it under government control. Also briefly considers its development in other countries, and applications which may possibly be made. 3000 w. Nineteenth Cent—July, 1906. No. 78002 D.

Telegraphy.

A Theoretical Study of Electric Circuits for Telegraphic Purposes (Theoretische Beschonwingen over Stroomketens voor Telegraphische Doellinden). J. C. D. M. de Roos. An exhaustive mathematical study of the most efficient current pressures for telegraphy. 30000 w. Tijdschr van het Kljk Inst van Ing—Feb. 3, 1906. No. 78186 H.

Telegraphy and Wireless Telegraphy During the San Francisco Disaster. W. R. Carroll. A brief account of the service rendered by the wireless system. 1200 w. Sci Am—July 28, 1906. No. 78268.

Telephony.

The Telephone in Railroad Service. H. L. Burdick and W. T. Saunders. General remarks on the growing use of the telephone in railway operation, with a description of the development on the Burlington system. Ills. 2800 w. Ry Age—July 20, 1900. No. 78094.

The Telephone Question of the Immediate Future (Telephonfrage der Nächsten Zukunft). Karl v. Barth. A review of the rapid development in the use of the telephone, with illustrations of some of the latest large exchanges in Europe. Two articles. 7000 w. Electrotech u Maschinebau—July 1, 8, 1906. No. 78171 each D.

Transformer Efficiency of Telephonic Induction Coils, as Related to Long Distance Transmission. D. McL. Therrell. Describes an arrangement of circuits claimed to be particularly advantageous over long-distance aerial, telephone circuits. 2000 w. Elec Wld—June 30, 1906. No. 77758.

DISTRIBUTION.

Cables.

Constants for Calculating the Heating of Cables (Die Material Konstanten zur Berechnung der Kabel auf Erwarmung). J. Teichmuller und P. Humann. Deriving a formula for computing the increase in temperature of cables with especial reference to the empirical constants for various materials. 6000 w. Elektrotech Zeitschr—June 21, 1906. No. 78162 B.

The Laying of a 10000-Volt Cable. Dr. Alfred Gradenwitz. An illustrated article showing the recent operation of laying a 10000-volt cable in Germany. 700 w. Sci Am—June 30, 1906. No. 77708.

Conduits.

Electrolier and Conduit Hangers. Thomas W. Poppe. Discusses matters relating to conduit work in dwellings, giving diagrams. 900 w. Elec Wld—July 7, 1906. No. 77871.

Wiring.

Points on Central Station Wiring. W. Barnes, Jr. Considers the importance of wiring, methods of tinning terminals and cables, location of cables, conduits, etc. Ills. 1500 w. Elec Jour—July, 1906. No. 78034.

ELECTRO-CHEMISTRY.

Accumulators.

Chemical and Physical Reactions of the Nickel Oxide Electrode in the Alkaline Accumulator (Ueber das Chemische und Physikalische Verhalten der Nickel-Oxyd-Elektrode im Jungner-Edison-Akkumulator). Julian Zedner. Data and results of experimental investigations in the laboratory of the university of Göttingen. 5000 w. Zeischr für Elektrochemie—July 6 1906. No. 78172 D.

The Alkaline Accumulator (Der Alkalische Akkumulator). Dr. Max Roloff. A study of the chemical reactions in the Edison alkaline storage battery. 4000 w. Elektroteck u Maschinenbau—June 17, 1906. No. 78169 D.

The Lines of Current in Storage Batteries—An Experimental Study. M. U. Schoop. Describes a method which permits studying, with relatively simple means, the distribution of the lines of current in electrolytes with sufficient exactness for all practical purposes. 3000 w. Elec-Chem & Met Ind—July, 1906. Serial. 1st part. No. 77918 C.

Colloids.

Colloids and Their Utilization. An explanation of the term, with some of the technical applications of colloids. 3800 w. Engng—July 6, 1906. No. 77978 A.

Electric Smelting.

Electric Smelting of Iron Ore. Abstract of Dr. Eugene Haanel's official preliminary report on the experiments made at Sault Ste. Marie, Ont. 3800 w. Elec-Chem & Met Ind—July, 1906. No. 77917 C.

Electric Smelting of Iron Ore. Phillips Thompson. Remarks on the results obtained by Dr. Eugene Haanel in the Sault Ste. Marie experiments. 1600 w. Eng & Min Jour—July 7, 1906. No. 77846.

Electrolysis.

Electrolysis of Dilute Solutions of Acids and Alkalis at Low Potentials: Dissolving of Platinum at the Anode by a Direct Current. George Senter. Read before the Faraday Soc. A report of experimental investigations, with conclusions. 3500 w. Elect'n Lond—July 20, 1906. No. 78298 A.

Electrometallurgy.

Electrometallurgy in 1905. John B. C. Kershaw. A review of the year's progress in the electrometallurgical industries. 1400 w. Eng & Min Jour—July 28, 1906. No. 78279.

The Electrolytic Deposition of Zinc Using Rotating Electrodes. T. Slater Price and G. H. B. Judge. Read before the Faraday Soc. A summary of the results thus far obtained in an investigation of the deposition of zinc from solutions of zinc sulphate, making use of a rotating cathode. 2000 w. Elect'n, Lond—July 6, 1906. No. 77970 A.

Furnaces.

An Electric Furnace for Heating Crucibles. Oliver P. Watts. Illustrates and describes a type of experimental furnace used in melting on a considerable scale moderately refractory metals, such as iron, and chromium. 2000 w. Elec-Chem & Met Ind—July, 1906. No. 77919 C.

Vertical Arc Furnaces for the Laboratory. Samuel A. Tucker. Gives plan and elevation of an arc furnace consisting essentially of a Moissan furnace of graphite, arranged vertically. 900 w. Elec Chem & Met Ind—July, 1906. No. 77916 C.

Nitrogen.

Artificial Production of Nitrate of Lime by Electric Discharge. John B. C. Kershaw. Remarks on the processes of different experimenters, giving a brief illustrated description of the method of Messrs. Birkeland and Eyde. 1500 w. Elec Wld—July 21, 1906. No. 78204.

On the Oxidation of Atmospheric Nitrogen in Electric Arcs. K. Birkeland. Read before the Faraday Soc. On the progress recently made with regard to the oxidation of atmospheric nitrogen, indicating its possible future advances, and describing the Birkeland-Eyde process. Ills. 2500 w. Elec Engr, Lond—July 6, 1906. Serial. 1st part. No. 77968 A.

The Electro-Chemical Problem of the Fixation of Nitrogen. Prof. Philippe A. Guye. Read before the Soc. of Chem. Ind. Slightly condensed. Deals especially with the commercial side of the question. 3000 w. Elect'n, Lond—July 13, 1906. Serial. 1st part. No. 78206 A.

Slags.

A New Apparatus to Determine the Melting Points of Slags. Woolsey McA. Johnson. Illustrated description of the apparatus and its use. 700 w. Elec-Chem & Met Ind—July, 1906. No. 77915 C.

ELECTRO-PHYSICS.

Earth Currents.

Report of the Commission of the German Gas and Water Companies for the Investigation of Earth Currents. Gives results of recent work. 1300 w. Elect'n, Lond—July 20, 1906. No. 78297 A.

Induction.

Effects of Self-Induction in an Iron Cylinder. Ernest Wilson. Read before the Royal Soc. An examination of what goes on in an iron cylinder when electric currents are reversed in it, and maintained steady after reversal. 1600 w. Elect'n, Lond—July 20, 1906. No. 78299 A.

Laboratory.

The National Physical Laboratory, Bushey House. Illustrated description of the new electrotechnical building, with an account of the newer work of the laboratory and its recent developments, especially in electrical matters. 1100 w. Elec Rev, Lond—June 22, 1906. Serial. 1st part. No. 77779 A.

Magnets.

Polyphase Magnets. D. L. Lindquist. Gives an outline of the features which should be embodied in the construction of polyphase magnets. 1000 w. Elec Wld—July 21, 1906. No. 78205.

Oscillations.

The Influence of the Armature Slots upon the Oscillations of Alternators (Ueber die Entstehung und Form von Oberschwingungen durch die Zähne der Wechselstromdynamos). Dr. K. Simons. An examination of the form and phase of the excess oscillations taken in connection with the relation of the armature slots to the poles. 1800 w. Elektrotech Zeitschr—July 5, 1906. No. 78167 B.

Resistivity.

The Resistivity Temperature-Coefficient of Copper. Dr. A. E. Kennelly. Shows a short and simple computation made with the aid of a given table. 400 w. Elec Wld—June 30, 1906. No. 77757.

GENERATING STATIONS.

Alternators.

A 120,000-Period Alternator. Emile Guarini. Illustrated description of this high-frequency alternator, showing some of the difficulties encountered in its construction. 1500 w. Sci Am Sup—July 7, 1906. No. 77830.

Heat Tests on Alternators. Sebastian Senstius. Gives a series of methods developed as substitutes for full-load heat-tests. 2500 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78042 D.

"Image Current" Alternators. G. Faccioli. A description of an alternator excited by low frequency currents whose armature reaction is compensated by image or reflected currents flowing internally in the machine. Also editorial. Ills. 2500 w. Elec Wld—July 14, 1906. No. 77962.

The Self-Synchronizing of Alternators. Morgan Brooks and M. K. Akers. Explains a method of using coreless inductances for safe synchronizing of alternators. 2000 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78047 D.

Armatures.

Series-Parallel Armatures with Equipotential Connections (Reihenparallelanker mit Alquipotential verbindungen). E. Arnold. With computations for the windings, and tables to aid in determining the connections. 6000 w. Electrotech Zeitschr—July 5, 1906. No. 78166 B.

The Estimation of the Temperature Rise of Armatures. A. Press. Showing the necessity for taking into account sparking at the commutator, as well as the relations between the commutator and armature losses. 500 w. Elec Wld—June 30, 1906. No. 77754.

Baltimore.

Steam Turbine Station of Baltimore Electric Power Company. J. R. Bibbins. Illustrated description of the Gould St. Station and its equipment. 2200 w. Elec Wld—July 14, 1906. No. 77959.

Central Stations.

Modern Central Stations. Frank C. Perkins. This first of a series of illustrated articles describes the gas engine plants at Münster, in Westphalia, and Zeitz, Germany. 1500 w. Cent Sta—July, 1906. Serial. 1st part. No. 77859.

Commutators.

Construction of Commutators for Dynamos. A. G. Ellis. An illustrated article tracing the building of the commutator, beginning with the raw material and ending with the finished commutator. 1200 w. Mech Engr—July 21, 1906. Serial. 1st part. No. 78302 A.

Dynamos.

High-Speed and High-Voltage Continuous-Current Dynamos. H. M. Hobart. Describes a study made by the writer for a 1000 kw. 1000 volt 1000 revs. per min. continuous-current dynamo. 1700 w. Elect'n, Lond—June 29, 1906. No. 77888 A.

Efficiency.

Relative Economies of Electrical Supply from Small Local Stations and from Power Companies. John F. C. Snell. Read before the Incor. Munic. Elec. Assn. Deals with the cost of generation, showing that small districts will find it more economical to take supply from outside source when available. 3300 w. Elec. Engr, Lond—June 22, 1906. No. 77777 A.

Hydro-Electric.

A Hydro-Electric Generating Station at South Bend, Ind. Illustrated detailed description of a generating station on the left bank of the St. Joseph River and its equipment. 2000 w. Eng Rec—July 14, 1906. No. 77935.

A Model Turbine Power Station. Illustrated description of the new turbine plant built by the Baltimore Electric Power Company. 2500 w. Eng Rec—July 21, 1906. No. 78075.

Contracting for Use of Hydro-Electric Power on Railway Systems. G. A. Harvey. Read before the N. Y. State Convention. Discusses the effect of load factor on the cost of power, and methods of billing for power, and matters of related interest. 2500 w. St Ry Jour—June 30, 1906. No. 77729 C.

Hydro-Electric Plant on the Upper Adda (Impianto Idro-Elettrico sull' Alta Adda). An account of the plans proposed for the establishment of an electric station on the Adda for the tranmission of power to Milan. 4000 w. Il Monitore Tecnico—June 30, 1906. No. 78180 D.

The Design of Hydro-Electric Installations as a Whole. E. F. Cassel. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Discusses some of the problems met in designing hydraulic installations. 1800 w. Eng Rec—June 30, 1906. No. 77720.

The Hydro-Electric Power Plant of the Nevada Power Mining & Milling Co. J. D. Galloway. Illustrated detailed description of this plant in Inyo Co., California which transmits power to Goldfield and Tonopah, in Nevada. An excellent example of long span construction. 2500 w. Eng Rec—June 30, 1906. No. 77718.

The Power Plant of the Electrical Development Company, of Ontario. F. O. Blackwell. Read before the Can. Elec. Assn. Detailed description of the plant and the transmission line. 3000 w. Elec Rev, N Y—July 28, 1906. No. 78259.

Parallel Running.

Notes on the Parallel Running of Alternators (Vorrichtung zum Selbsttätigen Parallelschalten von Drehstrommaschinen). Dr. G. Benischke. Describing automatic synchronizing devices for starting alternators in parallel. 3000 w. Elektrotech Zeitschr—July 5, 1906. No. 78168 B.

Paris.

The New St. Denis Electric Plant at Paris. C. L. Durand. Illustrated description of an interesting steam turbine plant under construction, and of its equipment. 6000 w. Elec Rev, N Y—July 28, 1906. No. 78258.

LIGHTING.

Arc Lamps.

Influence of the Curve of Electromotive

Force upon Arc Lamps (Einfluss der Kurve der Elektromotorischen Kraft auf Bogenlampen). C. Zorawski. Showing the influence of an irregular wave form in causing the production of noise in arc lamps. 1000 w. Elektrotech Zeitschr—June 28, 1906. No. 78164 B.

Incandescent.

A New Method of Assorting Incandescent Lamps According to Age. Dr. Clayton H. Sharp. Explains a method sufficiently exact for the separation of good lamps from those that have depreciated, which requires no special apparatus or skill. 1800 w. Elec Wld—July 7, 1906. No. 77868.

Large Rooms.

The Lighting of Large Public Rooms. J. R. Cravath and V. R. Lansingh. An illustrated article considering the lighting of hotel lobbies, large railroad depots, halls, etc., 2000 w. Elec Wld—July 7, 1906. No. 77867.

MEASUREMENT.

Circle Diagram.

Simple Circle Diagram of the Single-Phase Induction Motor. A. S. McAllister. Shows that when a polyphase induction motor is compelled to operate as a single-phase machine, by cutting one of the supply wires its current locus is still approximately a circle; but the circle shrinks in diameter about 50%. 2400 w. Elec Wld—June 30, 1906. No. 77755.

Currents.

Measurement of Feeble High-Frequency Currents. Bela Gati. On the measurement of very feeble telephonic currents outlining a method which does not require a special source of current. 1600 w. Elec Wld—June 30, 1906. No. 77756.

Harmonics.

Graphical Treatment of Higher Harmonics. R. Hellmund. Describes an interesting graphical method for determining the current which flows through impedances of different constants when subjected to a non-sinusoidal electromotive force. 600 w. Elec Wld—June 30, 1906. No. 77753.

Magnets.

A Chart for Use in Magnet Design. L. F. Howard. Gives a chart designed to give a quick and convenient means of obtaining the size of wire, or voltage, for different conditions. 1000 w. Elec Jour—July, 1906. No. 78033.

Photometry.

Some Causes of Error in Photometry. Lancelot W. Wild. Discusses errors due to several causes, and the general principles for the avoidance of angularity error. 1600 w. Elect'n, Lond—July 20, 1906. No. 78296 A.

Power.

The Sale and Measurement of Electric Power. S. B. Storer. Read before the N. Y. State Convention. Considers briefly the cost of production of power from hydro-electric plants and from steam plants and the question of rate making and methods of charging. 3500 w. St Ry Jour—June 30, 1906. No. 77730 C.

MOTORS.

Comparison.

Comparison of Two- and Three-Phase Motors. Bradley McCormick. Gives a comparison of the distribution factor, flux-variation factor, current density in rotor and stator, and the leakage factors. 1500 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78041 D.

Induction Motors.

The Effect of Voltage and Frequency Variations on Induction Motor Performance. Gerard B. Werner. An analysis dealing with the effects on the motor performance caused by variations in the supply circuit. 2500 w. Elec Jour—July, 1906. No. 78032.

Inter-pole.

Direct-Current Motor Design as Influenced by the Use of the Inter-Pole. C. H. Bedell. An explanation of the advantages gained by use of inter-poles. 2400 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78043 D.

Speed Control.

Direct Current Motor Speed Control. J. H. Newby. Read before the Elec. Assn. of N. S. W. Discusses methods of varying the speed of direct current motors, including the multiple voltage of three-wire balance system. 2200 w. Aust Min Stand—May 23, 1906. Serial. 1st part. No. 77780 B.

TRANSMISSION.

Arresters.

Some Experiences with Lightning and Static Strains on a 33000 Volt Transmission System. Farley Osgood. Explains the actions of the multigap series resistance type of arrester unit, and the multigap type of arrester unit without the series resistance, experienced during the years 1904 and 1905 on a system in Connecticut. Ills. 3000 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78044 D.

High Voltage.

100,000-Volt Experimental Transmission Line. K. Wernicke. Illustrates and describes an experimental line near Berlin, which has been tested and successfully proven that an installation operating at 100,000 volts is feasible when properly insulated. 1700 w. Elec Wld—July 14, 1906. No. 77961.

Low Frequency.

Stanley's System of Transmitting and Utilizing Low-Frequency Currents. Describes a system in which the principal advantages of alternating-current distribution and direct-current motors are present. Ills. 2000 w. Sci Am Sup—June 30, 1906. No. 77713.

Poles.

A New System for Line-Wire Poles (Eine Neue Befestigung von Leitungsmasten). S. Herzog. Describing a combination of wooden pole and concrete base, especially adapted for telegraph and electric transmission lines. 2000 w. Elektrotech u Polytech Rundschau—June 14, 1906. No. 78188 D.

Protective Apparatus.

. Methods of Testing Protective Apparatus. E. E. F. Creighton. Treats of the methods of testing arresters and dielectrics, and gives the conditions and precautions found necessary to obtain useful results. 8000 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78045 D.

Protective Apparatus for Lightning and Static Strains. H. C. Wirt. Discusses in detail the methods of protection used for high-tension transmission lines. Ills. 5000 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78046 D.

Three-Phase.

Direct-Current Transmission in Competition with the Three-Phase Alternating-Current System for Milan. Explains the general condition at Milan and the comparison made of the two schemes for the supply of power, which resulted in favor of the three-phase system. 800 w. Elec Rev, Lond—June 29, 1906. No. 77886 A.

Towers.

Towers for the Transmission Line between Ballston and Amsterdam, New York. Illustrates and describes the towers being built for a transmission line between Spier Falls and Utica, N. Y. 1000 w. Elec Rev, N Y—June, 30, 1906. No. 77736.

MISCELLANY.

Agriculture.

The Application of Electric Motors to Agricultural Purposes. Franz Koester. With numerous practical illustrations of examples in a profitable field for the extension of electric power. 2500 w. Engineering Magazine—August, 1906. No. 78192 B.

INDUSTRIAL ECONOMY

Accounting.

Method in Engineering Work. A. D. Williams, Jr. Describes a method devised for handling the engineering work, in shop and offices, for a concern building traveling cranes in a wide variety of sizes and types. 6000 w. Ir Age—July 12, 1906. No. 77904.

Address.

Address of Sir Alexander Richardson Binnie. Reviews the history and growth of the various branches of engineering, and considers those whose names are associated with its development. 7000 w. Inst of Civ Engrs—Nov. 7, 1905. No. 78016 N.

Engineering Honor. Schuyler Skaats Wheeler. President's address. Discusses the duties of an engineer to his client, the public, to the enginering societies, and gives an appendix on professional ethics. 12000 w. Pro Am Inst of Elec Engrs—June, 1906. No. 78040 D.

Civil Engineers.

Requisites of a Civil Engineer. Gen. William Sooy Smith. Gives some facts of interest from the experience of the writer, and discusses the requisites of a good engineer. 5000 w. Trans Assn of Civ Engrs of Cornell Univ—1906. No. 78037 G.

Co-operation.

Co-operation. Henry W. Thornton. Read before the Traffic Club of Pittsburgh. Especially considers co-operation between the traffic and operating departments of the same railroad, and co-operation between a railroad and an industry. 5500 w. Pro St Louis Ry Club—June 8, 1906. No. 77768.

Cost Keeping.

A Tool for Cutting Down Costs. F. E. Webner. The first of a series of twelve articles on cost keeping. 3000 w. Ir Trd Rev—July 5, 1906. No. 77807.

Dumping.

Some Dumping Dodges. William Taylor Heslop. Illustrated description of devices used in South Africa for loading and unloading material. 1200 w. Mines & Min—July, 1906. No. 77909 C.

Education.

Technical Education in Relation to Industrial Development. Charles G. Washburn. A review of the history of industrial development and industrial education in the United States. A Commencement address. 10000 w. Jour Worcester Poly Inst—July, 1906. No. 78003 C.

The Armstrong College, Newcastle-on-Tyne. Illustrated detailed description of the new extensions and the uses to which they are to be applied. 3000 w. Engr, Lond—July 6, 1906. No. 77990 A.

The Education of Mining Engineers. J. W. Gregory. Abstract of a paper read before the Inst. of Min. Engrs. Especially considers the needs of Great Britain, discussing the requirements. 3500 w. Ir & Coal Trds Rev—June 22, 1906. No. 77790 A.

The Relation Between Technical Education and Industrial Progress. Robert H. Richards. States facts relating to the development in the United States, and explains obstacles encountered. 6000 w. Tech Qr—June, 1906. No. 78005 E.

Egypt.

Egypt in 1905. Reviews such portions of Lord Cromer's annual report as are of interest to engineers. 4000 w. Engr, Lond—June 22, 1906. No. 77798 A.

Seven Years in the Soudan. Information from Lord Cromer's last report concerning the work accomplished during the last seven years. 2000 w. Engr, Lond—July 13, 1906. No. 78223 A.

Electricity.

Application of Electricity in the Development of American Industries and Manufacturing. Charles F. Scott. Remarks on power as the fundamental element in manufacturing operations, and the new methods made possible by electric power. 2500 w. Ind Wld—June 28, 1906. No. 77751.

Experiment Station.

The Engineering Experiment Station of the University of Illinois. An illustrated article giving a brief outline of the equipment of this station and the work it is purposed to carry on. 1200 w. Elec Rev, N Y—July 21, 1906. No. 78087.

Exposition.

The Milan International Exposition (L'Exposition Internationale de Milan). E. Lemaire. A well illustrated description of the buildings and grounds of the Milan exposition, celebrating the successful completion of the Simplon tunnel. 3500 w. Génie Civil—June 9, 1906. No. 78120 D.

Labor.

Chinese Labor in the Light of Modern Industry. Barrett Smith. A record of practical experience with coolie labor, expressing an optimistic opinion as regards the availability of Chinese labor for great engineering undertakings. 3500 w. Engineering Magazine—August, 1906. No. 78198 B.

Municipal Ownership.

Municipal Ownership in Germany. Hugo R. Meyer. Discusses the record of municipal failure in public service industries and the effect, especially in the development of electric railways. 2200 w. Elec Ry Rev—July, 1906. No. 77963.

Municipal Ownership: Three Important Changes in the Public Point of View. Charles Whiting Baker. Editorial presenting the substance of an address at Ithaca, N. Y., opening a discussion on the subject of municipal ownerships. 2000 w. Eng News—July 5, 1906. No. 77822.

Steel Industry.

The Growth of the Steel Industry. Harold Baxter. Discusses the cause of the present activity in the steel market, and the probability of finding iron ore in Colorado. 1800 w. Min Rept—July 19, 1906. No. 78091.

Tees-side.

Tees-side as an Industrial Center. A report of the project of developing districts outside of the large cities, for manufacturing purposes, presenting the considerations advanced to influence the choice of Tees-side for industrial works. 3000 w. Engng—July 6, 1906. Serial. 1st part. No. 77979 A.

Workmen's Houses.

General and Special Considerations upon the Design and Construction of Workmen's Dwellings (Allgemeines und Spezielles über den Bau und die Einrichtung von Arbeiterwohnungen). Dr. Henrici. A review of existing practice, showing the importance of combining convenience and comfort, with correct sanitation, with moderate cost. 3500 w. Zeitschr de Ver Deutscher Ing—June 16, 1906. No. 78102 D.

MARINE AND NAVAL ENGINEERING

American Navy.

American Naval Organization and the Personnel Law of 1899. George W. Melville. Discusses the working of this system, replying to points in a paper by Admiral S. B. Luce, in the *North American Review.* 3000 w. Cassier's Mag—July, 1906. No. 78000 B.

Battleships.

H. M. Battleship "Agamemnon." Illustrates and describes this recently launched vessel. Also editorial discussion. 3000 w. Engng—June 22, 1906. Serial. 1st part. No. 77795 A.

Modern Warships. Sir William White. Cantor lecture delivered Jan. 29, 1906. Describes the characteristic features of modern warships; materials and methods of construction; armor protection and armament; improvements in propelling machinery, growth in dimensions and cost. 5000 w. Jour Soc of Arts—June 29, 1906. Serial. 1st part. No. 77873 A.

The New Japanese Battleships "Katori" and "Kishima." J. B. Van Brussel. Illustrated detailed descriptions of the vessels and their equipment. 1600 w. Sci Am—July 21, 1906. No. 78062.

Boilers.

See Mechanical Engng., Steam Engng.

Coaling.

The Coaling of Ships at Sea (Le Ravitaillement en Mer des Navires). A Bidault des Chaumes. Describing especially the Temperley conveying apparatus, including the device by which the bucket is automatically locked to, and released from the carriage. 3000 w. Génie Civil—May 19, 1906. No. 78115 D.

Compass.

The Principles of the Deviation of the Compass and Its Correction. L. M. Nulton. An attempt to explain, by simple laws of magnets, how deviation is produced by the iron of a ship, and how it may be corrected. An explanation of principles involved, based upon the physical laws of attraction and repulsion of magnets. Ills. 6400 w. Pro U S Nav Inst—June, 1906. No. 78028 G.

Coupling.

The Lovekin Improved Inboard Coupling for Line and Propeller Shafts. Luther D. Lovekin. Considers a type of coupling being made for the U. S. battleship New Hampshire, explaining the advantages claimed. Ills. 1700 w. Jour Am Soc of Nav Engrs—May, 1906. No. 78027 H.

Cranes.

New Tower Cranes for Shipbuilding (Neuere Elektrisch Betriebene Helling-Turmdrehkrane). Illustrating some remarkable traveling tower jib cranes of 6 tons capacity on towers 35 metres high; built by the Benrath Machine Works for Bremen shipyards. 2000 w. Schiffbau—July 11, 1906. No. 78156 D.

Cruisers.

Steam Trials of H. M. Armored Cruiser "Cochrane." A report of trials, the results, so far as speed is concerned, proving quite satisfactory. 1200 w. Engng—July 13, 1906. No. 78216 A.

Trial Performance of United States Cruiser St. Louis. L. E. Baldt. An illustrated article giving a description of the vessel and its equipment, and of the trial trip. 4800 w. Int Marine Engng—August, 1906. No. 78201 C.

U. S. Armored Cruiser Tennessee. Lewis Hobart Kenney. Illustration, with detailed description of the machinery and tests. 12500 w. Jour Am Soc of Nav Engrs—May, 1906. No. 78026 H.

Design.

Approximate Dimensions for a "Compromiseless Ship." Richard D. Gatewood. Aims to show how to design the principal dimensions of such a ship. 4500 w. Pro U S Nav Inst—June, 1906. No. 78030 G.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Launch.

The Steam Launch Rose en Soleil. Illustrated detailed description of this motor-boat which beat all competitors at the Liverpool trials. 1200 w. Engr, Lond—July 13, 1906. No. 78224 A.

Liners.

The New Cunarders. Sir William H. White, in the *London Times*. A discussion of steamship propulsion, and the increase in speed required for these new vessels. 2000 w. Marine Rev—July 12, 1906. No. 77953.

The Twin Screw Passenger and Freight Steamer Kaiserin Auguste Victoria (Der Doppelschrauben-Passagier und Frachtdampfer Kaiserin Auguste Victoria). A detailed description of the new Hamburg-Amerika liner, with numerous illustrations. Serial. Part 1. 1800 w. 1 plate. Schiffbau—June 27, 1906. No. 78155 D.

The Twin-Screw Steamship Kaiserin Auguste Victoria (Der Doppelschraubendampfer Kaiserin Auguste Victoria). W. Kaemmerer. A very completely illustrated account of the new Hamburg-Amerika liner, including details of the equipment and machinery. 4000 w. 4 plates. Zeitschr d Ver Deutscher Ing—July 7, 1906. No. 78110 D.

Progress.

Technical Progress in the Merchant and Military Marine in the Last Decade (Die Technischen Fortschritte in der Handels und Kriegsmarine im Letzten Jahrzehnt). Hr. Ilgenstein. A review of the latest developments, including greater strength, stability and control; the use of electricity, telephones, wireless telegraphy, etc.; also submarines and torpedo boats. 4000 w. Zeitschr d Ver Deutscher Ing—June 23, 1906. No. 78105 D.

Steamers.

New Passenger and Freight Steamer City of Stamford. Illustrated detailed description of a new steamer for service between New York and Stamford. 700 w. Naut Gaz—July 12, 1906. No. 77913.

The New Canadian Pacific Twin-Screw Steamers. An illustrated description of the Atlantic liners "Empress of Britain" and "Empress of Ireland." 3000 w. Engng—July 20, 1906. No. 78313 A.

Steamships.

New Steamships for Pacific Coast. Illustrated description of a design for two fine coasting vessels for service between San Francisco and Seattle. 1600 w. Naut Gaz—July 19, 1906. No. 78086.

Transport.

The Military Transport Steamer Borussia (Der Truppentransportdampfer Borussia). Hugo Buchholz. A detailed description of the steamer built at the Krupp Germaniawerft for the Hamburg-Amerika Line, and adapted for military transport service in time of war. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 23, 1906. No. 78103 D.

Turbines.

Marine Turbines in Service. Robert S. Riley. Discusses the turbine question and its advantages and disadvantages. 2500 w. Int Marine Engng—August, 1906. No. 78203 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Adams-Hewett.

The Adams-Hewett Car. The first of a series of articles describing the details of this light, low-priced car. Ills. 900 w. Auto Jour—June 30, 1906. Serial. 1st part. No. 77881 A.

Berliet.

The Berliet Petrol Cars. Illustrated detailed description of these chain-driven cars. 1000 w. Auto Jour—July 21, 1906. No. 78294 A.

Carburetters.

Adapting the Carburetter Especially in Regard to Multi-Cylinder Engines. Suggestions resulting from observations of carburetter action. 2500 w. Autocar—July 7, 1906. No. 77967 A.

Congress.

The III International Congress of Automobilism at Milan (III Congresso Internazionale di Automobilismo in Milano). A series of reports by specialists upon the various departments of automobile construction as represented at the Milan exposition. Six articles. 10000 w. L'Industria—June 3, 10, 17, 24, July 1, 8, 1906. No. 78179 each D.

Decauville.

The 12-16 H. P. Decauville. Illustrates and describes the chassis of this car, which shows several distinctive and useful features. 2000 w. Autocar—July 21, 1906. No. 78293 A.

Gears.

Speed Changing Gears—The Planetary System. An illustrated explanation of the principles of its operation, and information relating to its use. 1800 w. Automobile—July 26, 1906. No. 78262.

Speed Changing Gears—The Sliding Gear. Diagram and description of typical three speed and reverse sliding gear transmission with direct drive on the high speed. 2300 w. Automobile—July 12, 1906. No. 77912.

Indicators.

Indicated Horse-Power and Indicators. Harold H. Brown. An explanation of the theoretical indicator and giving illustrated description of various types and of the "Manograph." 3500 w. Automobile—July 26, 1906. No. 78263.

Industrial Vehicles.

The Commercial Motor Vehicle in Great Britain. Ernest F. Mills. An illustrated review of the progress of this industry in Great Britain, giving related information. 2500 w. Cassier's Mag—July, 1906. No. 77997 B.

Manograph.

Indicating an Auto Motor at 1000 R. P. M. H. F. Donaldson. Illustrated description of an instrument, called a "manograph," which gives a photographic record of the work of the motor. Its operation is explained. 2500 w. Automobile—July 5, 1906. No. 77803.

Motor-Cycles.

The Design of the Motor Bicycle. Discusses the lines along which improvement is necessary. 1200 w. Engng—June 22, 1906. No. 77794 A.

Motor Wagon.

A Powerful Motor Wagon with Four Driving Wheels. Illustrated descriptions of a motor vehicle in which all the wheels are utilized in driving, steering and braking. 1000 w. Eng News—July 12, 1906. No. 77928.

Nevada.

Automobiling in the Desert. An illustrated article describing travel by automobiles in the mining regions. 2200 w. Min Wld—July 14, 1906. No. 77956.

Race.

The Grand Prize of the Automobile Club of France for 1906 (Le Grand Prix de l'Automobile Club de France en 1906). Ch. Dantin. A description of the run over the circuit de la Sarthe, won by Szisz, in a Renault machine. 3000 w. Génie Civil—June 30, 1906. No. 78123 D.

Renault.

The Winning Car of the Grand Prix, and the Detachable Rim. Illustrated detailed description of this Renault car, and the removable system of wheel rims used. 1500 w. Sci Am—July 28, 1906. No. 78267.

Siddeley.

The 32 H. P. Siddeley Car. Illustrated detailed description. 1200 w. Autocar—June 30, 1906. Serial. 1st part. No. 77883 A.

COMBUSTION MOTORS.

Alcohol.

Alcohol Fuel for Explosion Engines. Abstract translation of a paper by Karl Fehrmann, read before the German Auto. Tech. Assn. A report of investigations and results showing that the prospects of alcohol supplanting gasoline are not encouraging. 4500 w. Mech Engr—June 30, 1906. No. 77879 A.

Carbureter.

A New Adjustable Float-Feed Carbureter for Use with Gasoline or Alcohol. Illustrates and describes a carbureter which has a coil spring, that acts as a throttle in connection with a slightly movable needle valve placed in the spraying nozzle. 700 w. Sci Am—July 21, 1906. No. 78060.

Combustion Chamber.

Experiments on a Constant-Pressure Generator. C. M. Garland. A detailed description of experiments with a pressure generator, in which the products of combustion are mixed with steam generated by the heat of the combustion. 2500 w. Engineering Magazine—August, 1906. No. 78195 B.

Diesel Motor.

Application of the Diesel Motor to Navigation on the Lake of Geneva (Le Moteur Diesel et son Application à la Navigation sur le Lac Leman). P. Hoffet. A general account of the theory and high efficiency of the Diesel motor, with especial reference to the installation on the vessel "Venoge" on the lake of Geneva. 5000 w. Bull Tech de la Suisse Rom—June 25, 1906. No. 78173 D.

The Diesel Motor (Il Motore Diesel). A fully illustrated account of the manufacture and operation of the Diesel petroleum motor, with especial reference to the exhibits at Milan. Two articles. 4000 w. L'Industria—May 20, 27, 1906. No. 78178 each D.

Engines.

Four-Cylinder Reversible Internal-Combustion Engine. Illustrated description of a design of 4-cylinder vertical internal-combustion engine on the reversing type. 1200 w. Mech Engr—June 23, 1906. No. 77783 A.

Gas Engines.

Cycles, Design, and Regulation of Internal-Combustion Motors (Mode de Réglage, Cycles, et Construction des Moteurs à Combustion Interne). R. E. Mathot. A paper presented at the Liège Congress, giving an exhaustive review of the present state of the art. 15000 w. Revue de Mécanique—May 31, 1906. No. 78175 E + F.

Gas Engine Calorimetry. F. E. Matteson. A report of experiments made to determine the proportionate distribution of the heat. 1800 w. Am Mach—Vol. 29. No. 30. No. 78229.

Measurement of Friction in Gas Engines. A. H. Burnand. Explains a method of estimating friction by retardation curves, giving investigations made by the writer. 2000 w. Engng—July 13, 1906. No. 78220 A.

Some Large Gas-Engines. Illustrates and describes a large gas-engine, and gas-driven blowing-engines built in Germany. 1200 w. Engng—July 6, 1906. No. 77980 A.

Gas Power.

A Naval Gas Engine. M. Joachimson. Illustrated description of a marine engine and producer developed by M. Emil Capitaine, and an account of the methods used in overcoming some of the difficulties encountered. 2200 w. Mach, N Y—July, 1906. No. 77706 C.

Gas Driven Electric Power System. J. R. Bibbins. Illustrated description of such a system as exemplified in the Warren & Jamestown railway plant. 8000 w. Pro Engrs' Soc of W Penn—July, 1906. No. 78247 D.

Gas Power for Marine Work. Godfrey M. S. Tait. An investigation of the gas producer as a fuel generator for this class of work. 1000 w. Int Marine Engng—Aug., 1906. No. 78202 C.

Gas Turbine.

The Gas Turbine. Some Tests of its Practical Efficiency. C. E. Lucke. Data and results of experiments with compressed air upon a De Laval wheel, showing the improbability of high efficiency. 3000 w. Engineering Magazine—August, 1906. No. 78191 B.

Suction Gas.

Suction Gas Producer Plant at Wichita, Kan. Illustrated detailed description of a plant for electric driving of motors, elevator service, and lighting in a factory. 1800 w. Engr, U S A—July 16, 1906. No. 77995 C.

Suction Gas Producers for Tarry Fuels (Sauggaserzeuger für Teerbildende Brennstoffe). C. Diegel. Illustrating especially the Pintsch producer, in which the gas is drawn off from the middle of the fuel bed. 2000 w. Stahl u Eisen—July 1, 1906. No. 78148 D.

Valve Gear.

Thorneycroft's Valve Gear for Reversible Explosion Engines. Illustrated description of an arrangement of valve operating mechanism suitable for use with 4-cycle reversible internal-combustion engines. 1000 w. Mech Engr—July 21, 1906. No. 78304 A.

Valves.

Gas Engine Valve Construction. H. S. Brown. Considers in detail the requirements of each section of an inlet or exhaust valve for gas, gasoline, or oil engines, and their design and construction. Ills. 1200 w. Ir Age—July 19, 1906. No, 78013.

HEATING AND COOLING.

Hot Air.

An Improved Application of Hot-Air Heating. A. O Jones. Brief description of this system with an improved type of side-wall register for first floor rooms. Ills. 800 w. Heat & Vent Mag—July, 1906. No. 78242.

Fads and Fallacies in Hot-Air Heating. R. S. Thompson. Gives examples illustrating the wrong ideas held by many people in regard to the heating of buildings. 4500 w. Heat & Vent Mag—July, 1906. No. 78240.

Hot Water.

An Interesting Heating Plant. A. T. Hoyt. Illustrated description of a hot water plant which heats four greenhouses and a residence successfully. 2300 w. Dom Engng—July 14, 1906. No. 77941.

The Elimination of Redundant Parts in the Forced Circulation of Hot Water. A. H. Barker. Read before the Am. Soc. of Heat. & Vent. Engrs. Illustrated description of a system which dispenses with the calorifier tube, its traps and valves, and the redundant parts of the pump. 4500 w. Dom Engng—July 21, 1906. No. 78083.

Radiation.

Heat Losses and Heat Transmission. Walter Jones. Read at meeting of the Am. Soc. of Heat. & Vent. Engrs. Discusses methods of calculation for ascertaining what radiator, or pipe surface for hot water, will be required to give a desired temperature. 4500 w. Met Work—July 21, 1906. No. 78049.

Radiation from Extended Ribbed Surfaces in Steam Heaters (Wärmeabgabe der Rippenheizflächen bei Dampfheizkörpern). E. Ritt. A review of Rietschel's formula, discussing the heat units given off for a given temperature difference. 1000 w. Gesundheits-Ingenieur—July 7, 1906. No. 78157 B.

Wall Radiators vs. Long Pipe Coils. J. A. Donnelly. Considers the use of wall radiators in the place of pipe coils for heating buildings in which long coils are usually employed. 900 w. Heat & Vent Mag—July, 1906. No. 78241.

Refrigeration.

Refrigerator Design. Charles E. Edgar. Calls attention to faults in the usual arrangement of evaporating coils, and gives suggestions. Ill. 3000 w. Ice & Refrig—July, 1906. No. 77763 C.

Refrigeration System of the Model New Abattoir in New York City. Illustrated description of the provisions for cold storage, and a refrigerating plant designed especially for the preservation of dressed meats. 4000 w. Eng Rec—July 14, 1906. No. 77937.

Some Faults in Ice Machines. William Nottberg. Points out bad features of the present ice machines and accessories. 2000 w. Ice & Refrig—July, 1906. No. 77762 C.

The Commercial Importance of Refrigerating Processes (Wirtschaftliche Wirkungen der Kältetechnik). Hr. v. Linde. A review of the development of refrigerating machinery in the last 25 years, showing its great commercial importance in breweries, slaughter houses, storage warehouses, etc. 3000 w. Zeitschr d Ver Deutscher Ing—June 30, 1906. No. 78109 D.

HYDRAULICS.

Flow.

A Velocity Registering Device (Construction d'un Appareil à Enregistrer les Vitesses). M. Parenty. Describing a form of recorder for use with a modification of the Pitot tube for registering the flow of water through pipes and conduits. 7500 w. Ann d Ponts et Chaussées—I Trimestre, 1906. No. 78133 E + F.

Intensifier.

Steam Hydraulic Intensifier for Hydraulic Presses. Illustrates and describes an arrangement of drop valves, which close positively and are not liable to leak, used for controlling the admission and exhaust of steam to and from the steam cylinder of the intensifier. 1200 w. Mech Engr—July 7, 1906. No. 77975 A.

Power.

Sale of Water-Power from the Power Company's Point of View. C. E. Parsons. Read before the N. Y. State Convention. Describes the system of the Hudson River Electric Power Co., and some of the important works in connection with its high-voltage of transmission, and discusses methods of making contracts for railway energy. 5000 w. St Ry Jour—June 30, 1906. No. 77731 C.

MACHINE WORKS AND FOUNDRIES.

Air Furnaces.

Air Furnace Practice. Ralph H. West. From a paper read before the Am. Found. Assn. An illustrated article describing details of these furnaces and their working. 2000 w. Ir Age—July 5, 1906. No. 77771.

Boring.

An Ingenious Contrivance. Edward Sette. Illustrated description of an arrangement for boring connecting rod brasses on a blacksmith's drill press. 500 w. Ice & Refrig—July, 1906. No. 77764 C.

Brass.

Brass Melting and Mixing. Erwin S. Sperry, in *The Brass World*. Considers their effect on the quality of the casting. 4000 w. Mech Engr—July 14, 1906. No. 78209 A.

Cams.

Laying out Cams on the Castings. R. E. Weinland. Describes simple and practical methods for use in laying out ordinary cams. Ills. 1500 w. Am Mach—Vol. 29. No. 29. No. 78051.

The Design of Cams. W. O. Horsnaill. Gives examples illustrating the correct method of designing cams. 1300 w. Engr, Lond—July 20, 1906. No. 78316 A.

Castings.

Designing and Building a Machine Part. H. P. Fairfield. Illustrated description of a casting from its first inception, to the point where it becomes a finished part. 1200 w. Mach, N Y—July, 1906. No. 77705 C.

Direct Castings from the Blast Furnace. W. H. Butlin. Reports results obtained by mixing ores of different composition in the blast furnace, claiming that with necessary knowledge and skill in manufacture, as good results can be obtained as with a cupola. Ills. 2000 w. Cassier's Mag—July, 1906. No. 77999 B.

Chuck.

A Simple Magnetic Chuck. R. V. C. Brook. An illustrated description of a chuck designed to hold irregular castings and forgings such as milling cutters, dies, punches, etc., which had to be ground on their faces and could not be conveniently held in an ordinary chuck. 500 w. Mech Engr—July 14, 1906. No. 78210 A.

Compass.

The Compass Machine. C. H. Claudy. Illustrated description of the machine used for cutting compass cards. 1000 w. Am Mach—Vol. 29. No. 27. No. 77808.

Crank Shafts.

The Manufacture of Crank Shafts (Die Herstellung Gekröpfter Wellen). Fr. Schraml. Describing the methods and special tools for machining multiple crank shafts from solid steel forgings. 2500 w. Zeitschr d Ver Deutscher Ing—July 7, 1906. No. 78113 D.

Design.

Essentials in Engineering Design. A. T. J. Kersey. Discusses the essential features of a good design and the qualifications a young engineer should possess to produce designs satisfactory to the works manager. 1800 w. Mech Engr—June 30, 1906. No. 77876 A.

Dies.

Punch and Die Work. E. R. Markham. An illustrated article describing methods used in this work, and the different operations. 3300 w. Mach, N Y—July, 1906. Serial. 1st part. No. 77707 C.

Electric Driving.

First Electric Motor-Driven Rail Mill. Illustrated description of the equipment of the Edgar-Thomson plant at Bessemer, Pa. 1500 w. Ind Wld—July 7, 1906. No. 77824.

Electrical Works.

The Electrical Works of the Allis-Chalmers Company. Illustrated description of works located at Norwood, a suburb of Cincinnati, Ohio. 1800 w. Elec Rev, N Y—July 7, 1906. No. 77832.

Factories.

The Iron-Clad Manufacturing Company. An illustrated article describing the facilities for the welfare of employees, and some interesting things from a mechanical standpoint of this factory in Brooklyn. 3700 w. Am Mach—Vol. 29. No. 30. No. 78230.

Foundry.

Dark Secrets in Foundry Practice. William H. Parry. Read at meeting of Am. Found. Assn. Refers to prevalent practices which are guarded as secrets which are of little value. 1200 w. Ir Trd Rev—July 26, 1906. No. 78261.

Grinding.

Recent Grinding Machines for Tools (Neuere Schleifmaschinen für Werkzeuge). G. Schlesinger. Illustrating improved machines for sharpening saws, twist drills, milling cutters, etc. 2000 w. 1 plate. Zeitsch d Ver Deutscher Ing—June 30, 1906. No. 78107 D.

Headstocks.

A Study in All-Gear Heads. Thomas R. Shaw. Explains the meaning of the term "all-gear," and gives illustrated descriptions of types. 2000 w. Mech Engr—July 14, 1906. Serial. 1st part. No. 78208 A.

Jigs.

Shop Tools and Methods. F. J. Le Card. Illustrated description of jig work. 600 w. Am Mach—Vol. 29. No. 28. No. 77922.

Lubrication.

Theory and Practice of Lubrication. J. W. G. Brooker. Abstract of a paper read before the Auto-Cycle Club. Considers solid and fluid friction, discussing the properties of lubricants and other related matters. 3000 w. Mech Engr—June 30, 1906. No. 77880 A.

Milling.

An English Slab-Milling Machine. James Vose. Illustrated description of a special high-speed slab-milling machine, designed for milling the sides of locomotive connecting rods, etc. 1000 w. Am Mach—Vol. 29. No. 27. No. 77810.

Molding.

Molding a Draw-bench Casting in a Flask, and also by Using the Floor as a Drag and Bedding, in the Pattern. R. H. Palmer. An illustrated article describing the differences in the construction of the patterns required to allow them to be molded easily in the two ways shown. 1800 w. Am. Mach—Vol. 29. No. 27, No. 77809.

Molding a Heavy Balance Wheel. Illustrates and describes a method which gave good results. 800 w. Am Mach—Vol. 29. No. 28. No. 77921.

The Position of Patterns in the Molds. Walter J. May, in the *English Mechanic and World of Science.* An illustrated article giving suggestions for a number of castings. 2500 w. Sci Am Sup—July 14, 1906. No. 77931.

Molding Machines.

Pattern Mounting on the Molding Machine. F. W. Hall. Discusses methods of mounting, illustrating by examples. 3000 w. Am Mach—Vol. 29. No. 28. No. 77920.

Pipes.

Modern Pipe Founding. H. A. Croxton. Read before the Am. Found. Assn. Remarks based on a pipe foundry with a yearly capacity of 60,000 tons, considering the choice of pig iron, flasks and cores, crane equipment, etc. 1700 w. Ir Age—July 19, 1906. No. 78014.

Piston-Rings.

Making a Piston-Ring. Illustrates and describes the processes by which piston-rings for Napier automobile engines are finished. 700 w. Auto Jour—June 30, 1906. No. 77882 A.

Pressure Tanks.

The Construction of Reservoirs to Sustain High Pressures (Sur la Construction des Réservoirs à Haute Pression). H. Royer. Discussing the construction of tanks or cylinders to contain compressed air, gases under high pressure, etc.; suggesting reinforcement by wire winding. 8000 w. Revue de Mécanique—June 30, 1906. No. 78176 E + F.

Press Work.

Some Progress in Simple Press Work. H. J. Bachmann. An illustrated discussion of operations on the power press in the working of sheet metals. 1500 w. Mach, N Y—July, 1906. No. 77704 C.

Punching.

Automatic Channel-Strip Punching-Machine. Illustration with brief description of a machine designed to punch holes at equidistant pitch in channel-shaped shrouding-rings used in a system of turbine blading. 300 w. Engng—June 29, 1906. No. 77892 A.

Reversing Gear.

Reversing Gear for Machine Tools. Illustrated description of a design of reversing gear for lathes and other similar tools. 1200 w. Mech Engr—July 7, 1906. No. 77974 A.

Shops.

Hicks Locomotive and Car Works. Illustrated description of Chicago works for repairing cars and locomotives, building new equipment, etc. 1200 w. R R Gaz—July 6, 1906. No. 77815.

Shop Extensions at the Plant of the Allis-Chalmers Co., Milwaukee, Wis. Illustrated descriptions of extensive additions to increase the capacity of the plant. 2000 w. Eng News—July 12, 1906. No. 77924.

Tools.

Tools for Machining Brass Type-Wheels. Edward Snyder. Illustrates and describes tools designed for the purpose of turning the rims and finishing the holes, shoulders, and ends of the hubs of cast-brass type-wheels. 3500 w. Am Mach—Vol. 29. No. 27. No. 77811.

Tool Works.

Worth Valley Tool Works, Keighley. Illustrated detailed description of these works which have been recently extended and rearranged. 2000 w. Engr, Lond—July 20, 1906. No. 78319 A.

Torsion Stresses.

Torsion Stresses at Sharp Cornered Shoulders on Shafts (Die Beanspruchung auf Verdrehen an einer Uebergangstelle mit Scharfer Abrundung). A Föppl. Showing the manner in which the cutting of a sharp shoulder on a shaft reduces the torsional resistance, and urging the use of liberal fillets. 2500 w. Zeitschr d Ver Deutscher Ing—June 30, 1906. No. 78108 D.

Welding.

Thermit Welding. R. P. C. Sanderson. Reviews the history of the methods covered in gaining success in the use of Thermit for welding locomotive frames. Also discussion. 3000 w. Pro S & S-W Ry Club—April 19, 1906. No. 78015 E.

MATERIALS OF CONSTRUCTION.

Abrasives.

Abrasive Materials. Joseph Hyde Pratt. Information concerning the production of abrasive materials, and their value. 2500 w. Ind Wld—June 28, 1906. No. 77752.

Alloys.

Losses in Making Alloys. Walter J. May. Calls attention to the unnecessary loss due to carelessness, giving suggestions. 800 w. Prac Engr—July 20, 1906. No. 78301 A.

The Physical Properties of Metallic Alloys (Physikalische Eigenschaften von Metallegerungen). Walter Rübel. A review of the modern study of alloys by the methods of metallography, showing the extent to which the properties are revealed by the appearance of the physical structure. 3500 w. Glasers Annalen—July 1, 1906. No. 78144 D.

Cast Iron.

Malleable Cast Iron. G. A. Akerlind. Abstract of a paper read at meeting of the Scandinavian Tech. Soc. Reviews the manufacture of malleable cast iron in its different stages and considers it as a material of construction. 2500 w. Mech Engr—June 30, 1906. No. 77877 A.

The Beneficial Effects of Adding High Grade Ferro-Silicon to Cast Iron. Alexander E. Outerbridge, Jr. Read before the Am. Found. Assn. A report of experiments and results obtained by controlling the proportion of silicon, showing a reliable means of producing soft, but strong castings, from metal of medium grade. 3000 w. Ir & Coal Trds Rev—June 29, 1906. No. 77899 A.

Hardening.

The Molecular Changes in Hardening (Die Molekularen Vorgänge beim Hörten). Otto A. Böhler. An address explaining the phenomenon of the hardening of steel according to the solution theory, with illustrations of cooling curves. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 30, 1906. No. 78151 D.

Impact Tests.

Repeated-Impact-Testing Machine at the National Physicial Laboratory. Illustrated description of a self-acting machine and its operation. 700 w. Engng—July 13, 1906. No. 78214 A.

Manganese.

Some Uses of Pure Manganese and Its Alloys. Remarks showing the large field of usefulness for this metal and its value to the metal founder. 1200 w. Ir & Coal Trds Rev—June 29, 1906. No. 77900 A.

Pig-Irons.

Specifications for Foundry Pig-Irons. W. B. Parker. Discusses the possibility of evolving a system without unduly disturbing present systems of supply. The composition and grading are considered. 7500 w. Ir & Coal Trds Rev—June 29, 1906. No 77898 A.

Steels.

Investigations on Steels Containing Copper (Recherches sur les Aciers au Cuivre). Pierre Breuil. Preliminary data upon copper-steel alloys showing the hardening action of the copper, and the singular points in the cooling curve. 1500 w. Comptes Rendus—June 18, 1906. No. 78126 D.

Nickel and Carbon Steels. Edward Dixon. Discusses results of recent investigations and their importance in the developments of petrol engines. 1000 w. Engng—July 6, 1906. No. 77985 A.

The Strength and Ductility of Steel. F. E. Cardullo. A discussion of the elements present in the steel, and how strong and how tough the various substances make it; also the effect of treatment during the process of manufacture. 2500 w. Mach, N Y—July, 1906. No 77701 C.

Testing Machine.

Purdue University Impact Testing Machine. W. K. Hatt and W. P. Turner. Read before the Am. Soc. for Test. Mat. Mentions three impact testing machines in the equipment of the laboratory, and illustrates and describes an improved machine for scientific and standard tests in compression and flexure. 2000 w. Ry & Engng Rev—June 30, 1906. No. 77735.

Tool Steel.

High-Speed Steel in the Factory. O. M. Becker. The seventh paper of the series discusses speeds and feeds with alloy steels showing the practical results which may be expected in the shop. 4000 w. Engineering Magazine—August, 1906. No. 78196 B.

High-Speed Tool Steel Tests. A report of the interesting tests of high-speed steel tools carried out on cast iron, at the University of Illinois Engineering Experimental Station, U. S. A. 2500 w. Engng—July 20, 1906. No. 78305 A.

The Internal Structure of Hardened and Tempered Tool Steel (Ueber den Innern Aufbau Gehärteten und Angelassenen Werkzeugstahls). E. Heyn & O. Bauer. A study of the relation of the constituents Troostite and Sorbite in hardened carbon tool steels. Serial. Part I. 3500 w. Stahl u Eisen—July 1, 1906. No. 78146 D.

Wastes.

Utilization of Waste Materials. From the German of Dr. Theodore Koller. Deals with the utilization of amber scrap, paraffine waste, furrier's waste, etc. 2500 w. Sci Am Sup—June 30, 1906. No. 77712.

MEASUREMENT.

Crank Motion.

Dynamic Force Plan for Crank Motions (Dynamischer Kraft plan des Kurbelgetriebes). Ferdinand Wittenbauer. A brief description of a method of projecting the action of the forces of a crank and connecting-rod motion in a graphical diagram. 1000 w. Zeitscher d Ver Deutscher Ing—June 16, 1906. No. 78101 D.

Flow.

Measuring Apparatus for Gases Flowing Through Pipes. Illustrated description of the Beardmore measuring and recording apparatus and its operation. 900 w. Mech Engr—June 30, 1906. No. 77878 A.

Gases.

Constants for Gases. Reviews the calculations of J. D. Van der Waals, Sr., and J. D. Van der Waals, Jr., and of Daniel Berthelot and others. 1400 w. Engng—July 20, 1906. No. 78307 A.

Hardness.

Apparatus for Determining Hardness by the Brinell Ball Test. The essential principle of this test consists in forcing a hardened steel ball partly into the test sample so as to effect a slight impression, the dimensions of which serve as a basis for determining the hardness. Ills. 1200 w. Am Mach—Vol. 29. No. 29. No. 78052.

Measuring Machine.

An Electrical Measuring-Machine for Engineering Gauges and Other Bodies. P. E. Shaw. Abstracted from the Phil. Trans. of the Roy. Soc. Describes a method having the advantage of being more sensitive than the old method, and giving an illustrated description of the machine used. 5000 w. Engng—June 29, 1906. No. 77896 A.

Planimeter.

The Polar Planimeter and Some of Its Special Applications. J. Y. Wheatley. A brief description of the instrument, its construction and operation, explaining the general principle. 4500 w. Am Mach—Vol. 29. No. 29. No. 78053.

Speed Indicator.

The Frahm Speed and Frequency Indicator (Der Frahmsche Frequenz und Geschwindigkeitsmesser). F. Lux. Illustrating the latest improvements in the Frahm indicator of vibrating springs; showing special receivers and transmitters for different speeds. 4000 w. Glasers Annalen—July 1, 1906. No. 78143 D.

Springs.

Diagram for Computing the Dimensions of Springs (Rechentafel für Feder berechnung). Dr. R. Proell. A graphical diagram for helical springs, enabling the relations of dimensions, extension, compression, and load to be determined by direct measurement. 1200 w. Zeitschr d Ver Deutscher Ing—July 7, 1906. No. 78114 D.

POWER AND TRANSMISSION.

Brakes.

Design of the Weston Load Brake. Ulrich Peters. Gives sectional views of one of the best mechanically designed brakes for cranes and other hoisting machinery and the calculations. 800 w. Mach, N Y—July, 1906. No. 77702 C.

Chain Belts.

History of the Link-Belt Industry. James M. Dodge. An illustrated review of the development. 3000 w. Ind Wld —June 28, 1906. No. 77749.

Coal Handling.

Tests of the Coal-Handling Plant at Breslau (Versuche an der Kohlenumladeanlage in Breslau). O. Kammerer. Detailed description and report of tests of cantilever coal-handling plant with diagrams from recording wattmeter and details of capacity and cost of operation. 4000 w. Zeitschr de Ver Deutscher Ing —July 7, 1906. No. 78111 D.

Transporter Cranes at Purfleet. Illustrated description of two rapid working hydraulic transporter cranes with grab-buckets, designed for lifting coal. 500 w. Engr, Lond—July 20, 1906. No. 78320 A.

Compressed Air.

Compressed Air as a Motive Power in the Quarry. George H. Gillman. Remarks on the applications of compressed air to quarry work, discussing some drawbacks and the remedies. 1000 w. Compressed Air—July, 1906. No. 77766.

German Designs of Air Compressors. M. Kurth. Illustrates and describes some of the more important designs, and those of particular interest. 2200 w. Am Mach—Vol. 29. No. 30. No. 78228.

Recent Extensions of the Employment of Compressed Air. Frank Richards. Notes on the development of the return-air pumping system, the electric-air rock drill, and the high pressure transmission of artificial gas. 2200 w. Eng News—July 26, 1906. o. 78231.

The Air Power Plants of the East River Tunnels of the Pennsylvania Railroad. An illustrated detailed description of these stations and their equipment. 5000 w. R R Gaz—July 27, 1906. No. 78264.

Elevators.

Electricity in Elevator Service. S. Morgan Bushnell. Discusses the relative advantages of electric and hydraulic equipments. 2500 w. Cassier's Mag—July, 1906. No. 78001 B.

Horse-Power.

What is Horse-Power? An elementary explanation of the term. Ills. 1700 w. Auto Jour—July 21, 1906. Serial. 1st part. No. 78295 A.

Power Plants.

Primary Considerations in the Designing of Power Plants. A. E. Dixon. The introduction of a series covering broadly the entire subject of the power station. The present article considers the preparation of plans and the supervision of contracts. 3000 w. Engineering Magazine—August, 1906. No. 78197 B.

Residence Plant.

Mechanical Equipment of the New Residence of Senator Clark in New York. Illustrated detailed description of the plant for a 7-story and basement stone structure, equipped with Turkish bath, swimming pool, refrigerators, elevator plant, indirect heating, air filters, temperature regulators, steam, etc. 6000 w. Eng Rec—July 7, 1906. No. 77837.

Spiral Gears.

The Spiral-Gear Problem Simplified. John Edgar. Gives practical rules, with examples showing their application. 1200 w. Am Mach—Vol. 29. No. 29. No. 78054.

Telpherage.

Electric Telpher for Conveying Coal. Illustrated description of the telpherage installation for conveying coal at the Bevan works of the Associated Portland Cement Mfrs., Ltd. 1500 w. Engng—July 13, 1906. No. 78217 A.

STEAM ENGINEERING.

Accessories.

Steam Plant Accessories. John T. Farmer. Presented before the Canadian Elec. Assn. Considers feed water, pipe coverings, fuel economizers, mechanical firing, draft, etc. Ills. 14400 w. Can Elec News—July 1, 1906. No. 78071.

Agricultural Show.

The Royal Agricultural Society's Show at Derby. Description and illustrations of exhibits of steam engines, and gas and oil engines are given in the present number. 3000 w. Engng—June 29, 1906. Serial. 1st part. No. 77895 A.

Boilers.

Some Essentials in Locomotive Boiler Design. D. Van Alstyne. Read before the N.-W. Ry. Club. Discusses points of importance in securing reliability and efficiency. General discussion. 3300 w. R R Gaz—July 20, 1906. No. 78059.

Water-Tube Boilers for Marine Service. William Ledyard Cathcart. A lecture before the Naval Archt. Soc. of the Mass. Inst. of Tech. Considers the effect of water-tube boilers on heat transmission, their requirements for marine service, gives details of construction of the Babcock & Wilcox marine boiler, tests, etc. Ills. 7500 w. Tech Qr—June, 1906. No. 78006 E.

Condensation.

Air in Relation to the Surface Condensation of Low-Pressure Steam. A report of experimental researches on the effect of gases—specifically atmospheric air—upon working efficiencies, showing that air should be rigorously excluded from high-grade surface-condensing installations. 4000 w. Engr, Lond—July 20, 1906. Serial. 1st part. No. 78322 A.

Efficiency.

Efficiency of Steam Plant. Walter A. Vignoles. Reports an investigation of the coal consumption in a central station, giving tests made, and discussing results. 4000 w. Mech Engr—June 23, 1906. No 77784 A.

Efficiency of Steam Plant. Walter A. Vignoles. Read before the Incor. Munic. Elec. Assn., London. An analysis of the coal and steam consumption of a central station, with a view to showing where the losses are incurred and how they can best be reduced. Also discussion which includes Mr. Wilkinson's paper. 8000 w. Elect'n, Lond—July 6, 1906. No. 77972 A.

Engines.

A New Vertical Steam Engine. George W. Heald. Illustrations and description of the special features of a new Bates engine. 1000 w. Engr, U S A—July 2, 1906. No. 77747 C.

High Power Steam Engines at Berlin. Illustrated description of engines and generators at the Moabit central station, Berlin, and at the Oberspree station. 1800 w. Engr, Lond—June 22, 1906. No. 77799 A.

Exhaust Steam.

The Rateau Exhaust-Steam Regeneration and Utilization Plant. An illustrated description of the plant installed at the Hallside Works of the Steel Co. of Scotland. 2200 w. Engng—June 29, 1906. No. 77893 A.

The Recovery of Power from Exhaust Steam (Kraftgewinnung aus Abdampf). Karl Rubricius. A discussion of various attempts to recover the energy rejected with the exhaust of steam engines with especial reference to the Rateau steam accumulator and low-pressure turbine. 4000 w. Elektrotechnik u Maschinenbau—June 24, 1906. No. 78170 D.

Feed Water.

Feed Water Heaters in Connection with Heating Systems. William G. Snow. Read at meeting of the Am. Soc. of Heat & Vent. Engrs. An illustrated article pointing out certain features in the application of feed water heaters in connection with heating systems. 2000 w. Met Work—July 21, 1906. No. 78048.

Live-Steam-Heated Feed Water—Its Effect on the Output and Efficiency of Steam Boilers. G. Wilkinson. Read before the Incor. Munic. Elec. Assn. Discusses the increasing the capacity of boilers designed for high duty, the range of temperature in boiler water, the methods of heating feed water, experimental work, etc. 9500 w. Elec Engr, Lond—June 29, 1906. Serial. 1st part. No. 77884 A.

Fire Boxes.

Firebox Steel—Failures and Specifications. Max H. Wickhorst. Abstract of a paper read at meeting of the Am. Soc. for Test. Mat. Discusses the conditions of failures, temperature tests, mud accumulations, and specifications. 2000 w. Ry Age—June 29, 1906. No. 77733.

Firing.

Mechanical Stoking Economics. A.

S. Atkinson. Does not consider automatic stokers a gain in plants smaller than 2000 h.p. capacity. Discusses the skill in hand firing, and in the handling of automatic stokers. 2500 w. Engr, U S A—July 2, 1906. No. 77748 C.

Modern Improvements in Firing Methods (Neuere Erfahrungen in Feuerungs betrieben). A. Blezinger. Describing especially improvements in the production and use of gaseous fuel for heating and boiler furnaces. 4500 w. Stahl u Eisen—June 15, 1906. No. 78145 D.

Fuel.

Burning Low-Grade Fuel. James F. Hobart. Considers boiler firing with coal containing a large percentage of ash, slate and other incombustible matter. 3000 w. Elec Wld—July 7, 1906. No. 77870.

Crude Oil Burning at Eagle Mills, Newton, Mass. Percy H. Wayne. Describes briefly the mills and their equipment, and the Hammel device used for oil burning. Ills. 1400 w. Engr, U S A—July 16, 1906. No. 77994 C.

Liquid Fuel for Steam-Raising. A review of the recent report of the United States Naval Board on the series of tests carried out to determine the relative value of coal and liquid fuel for naval purposes. Considers only the liquid fuel results. Ills. 4000 w. Engng—July 20, 1906. No. 78306 A.

Liquid versus Coal Fuel. W. N. Best. A comparison, favoring liquid fuel. Ills. 1700 w. Sci Am Sup—July 7, 1906. No. 77828.

Lubrication.

Forced Lubrication in Engines of H. M. S. "Africa." Drawings and description of the forced lubrication system applied to the main propelling machinery of this vessel. 900 w. Engng—July 6, 1906. No. 77983 A.

Oiling Systems for Electric Engines. W. H. Wakeman. Illustrates and describes a number of systems. 1600 w. Elec Wld—July 7, 1906. No. 77869.

New Devices.

Notes from Abroad. E. Guarini. Illustrates and describes a new draft gage, new form of water gage, a leakage indicator, and other devices. 1000 w. Engr, U S A—July 16, 1906. No. 77996 C.

Steam Jackets.

Recent Experiments on the Efficiency of Steam Jackets (Der Nutzen des Dampfmantels nach Neueren Versuchen). A. Bantlin. A review of the experiments of Prof. D. S. Capper, forming the report to the Steam Engine Research Committee of the Institution of Civil Engineers. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 7, 1906. No. 78112 D.

Steam Valve.

The Hopkinson-Ferranti Steam Valve. Illustrations, with description, of a radical departure in valve construction. The valve works upon the principle of converting the pressure of the fluid into velocity, and then reconverting the velocity into pressure again by means of a suitably formed nozzle. 1500 w. Engng—June 29, 1906. No. 77894 A.

Turbines.

Comparison between Pressure and Impulse Turbines (Vergleich der Druck und Ueberdruck-Dampfturbinen). Donat Banki. A mathematical computation showing that the loss of energy in the pressure turbine is 1.4 times that in the impulse turbine. 1200 w. Zeitschr d Ver Deutscher Ing—June 16, 1906. No. 78100 D.

Tests of a 500-Kilowatt Steam-Turbine Unit. Illustrated description of the turbine giving results of tests made by Prof. Schröter, of Munich. 1500 w. Engng—July 6, 1906. No. 77982 A.

The Steam Turbine. Charles Algernon Parsons and George Gerald Stoney. Reviews the early history, explaining the general theory and principles, and describing the Parsons, DeLaval and Curtis turbines. Gives results of trials and general discussion. Ills. 21500 w. Inst of Civ Engrs. No. 3548. No. 78018 N.

Steam Turbines. Sydney W. Baynes. Read before the Incor. Munic Assn. (Slightly abridged). Illustrates and describes most of the makes of steam turbines on the market. Discussion. 10700 w. Elect'n, Lond—June 22, 1906. No. 77781 A.

See also Electrical Engineering, Generating Stations.

MINING AND METALLURGY

COAL AND COKE.

Coalfields.

Theory of the Foundation and Occurrence of Coalfields. James Ford. Considers the coalfields were once vast swampy peat-bogs or masses of vegetation forming in standing water, and that the vegetation was mostly of small aquatic species. 3800 w. Ir & Coal Trds Rev—July 13, 1906. No. 78225 A.

Coal Washing.

The Henry Experiments in Coal Washing (Ingenieur Henrys Aufbereitungsversuche mit Kohlen). Julius Divis. Describing the experimental apparatus at the Hasard colliery, Micheroux, Belgium, for determining the best conditions for washing coal of various sizes. Two articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 16, 23, 1906. No. 78149 each D.

Coke.

The Mechanical Handling of Hot Coke. George Frederick Zimmer. Deals with conveyors suitable for use in gas works, believing that larger conveyors of similar design may be adopted in coke-oven installations. Ills. 5000 w. Inst of Civ Engrs—No. 3568. No. 78023 N.

Colliery Equipment.

The Work of the Mining Engineer in Connection with the Construction and Equipment of Bituminous Collieries and Coke Plants. William Glyde Wilkins. On the requirements of the constructing mining engineer of today. 1500 w. Ind Wld—June 28, 1906. No. 77750.

Deep Mines.

Considerations on Deep Coal Mines. George Farmer. Abstract of a paper read at meeting of the Inst. of Min. Engrs., London. Discusses the physical difficulties encountered at great depths. 2000 w. Min Wld—July 7, 1906. No. 77850.

Illinois.

The Peabody Mines, Southern Illinois. R. S. Moss. A description of the Carterville seam, and especially of the No. 3 mine of the Peabody Coal Co., with illustrations. 900 w. Min Wld—July 21, 1906. No. 78089.

Philippines.

Philippine Coal Deposits. H. L. Wigmore. An illustrated article giving an account of diamond drilling in the Philippines and the development of the coal deposits of Batan Island. 7500 w. Mines & Min—July, 1906. No. 77905 C.

Russia.

The Coal and Carboniferous Deposits of Far Eastern Russia (Die Fossilen Kohlen und Kohlenstoffverbindungen des fernen Ostens Russlands). A. M. Ossendowsky. A tabulated report of the various coal, lignite, peat, and petroleum resources of Siberia, Manchuria, and Sakhalin, from a chemical viewpoint. Three articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 23, 30, July 7, 1906. No. 78150 each D.

Spontaneous Ignition.

The Spontaneous Ignition of Coal. Vivian B. Lewes. Abstract of a lecture before the British Soc. of Arts. Considers the danger from this trouble when coal is stored in bulk, the means of preventing, and methods of extinguishing such fires. 1400 w. Eng & Min Jour—July 14, 1906. No. 77944.

Storage.

Ransom Coal-Storage Plant. Illustrates and describes a plant arranged for storing a half-million tons of coal and reloading it without hand work. 3000 w. Mines & Min—July, 1906. No. 77906 C.

Stripping.

Coal Mining by Open Stripping in Pennsylvania. F. W. Parsons. An illustrated article describing the method of working a coal seam in the Hazleton district. 1400 w. Eng & Min Jour—June 30, 1906. No. 77745.

Submarine Mines.

Submarine Coal Mining. Richard H. Brown. From *Jour. of the Min. Soc. of Nova Scotia.* Particulars connected with the operation of the largest of the six collieries of Cape Breton, now working under water. 1600 w. Min Rept—July 12, 1906. No. 77955.

Submerged Coal.

Submerged Salt-Water Storage for Coal. W. H. Beehler. Shows the dangers and losses caused by fires in coal stored in bulk, and urges the experiment of storing under salt water, giving information bearing on the subject. 4000 w. Pro U S Nav Inst—June, 1906. No. 78029 G.

United Kingdom.

The Coal Resources of the United Kingdom. J. L. Pultz. Notes from the final report of the Royal Commission on Coal Supplies, 1905. 1200 w. Eng & Min Jour—July 7, 1906. No. 77845.

COPPER.

Blast Furnaces.

The Washoe Plant of the Anaconda Copper-Mining Co. in 1905. L. S. Austin. Illustrated detailed description of the numerous departments of this extensive plant, the construction, operation, advantages, etc. 16000 w. Bul Am Inst of Min Engrs—July, 1906. No. 78250 D.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Extraction.

Extraction of Copper from Pyrites Cinders or Poor Ore, with Direct Production of Sulphate of Copper from the Lixiviation Liquids. Carl Milberg. Translated from *Rassegna Mineraria.* Gives the main points of the process and the results. 2300 w. Min Jour—June 30, 1906. No. 77889 A.

Gribbell Island.

Gribbell Island—Its Geology and Mining Operations. W. M. Brewer. Information concerning this island, which is about 150 miles north of Vancouver Island. The development of two copper mining companies is described. 2500 w. B C Min Rec—June, 1906. No. 78085 B.

Low-grade Ores.

Ely, Nevada. Arthur H. Halloran. A description of this region and the deposits of low-grade copper ores, the mine workings, etc. 2000 w. Min & Sci Pr—July 5, 1906. No. 77954.

Mount Lyell.

The Mount Lyell Copper Mine. S. A. Ionides. Illustrated description of this low-grade copper mine on the west coast of Tasmania, and the method of extraction. 1000 w. Min & Sci Pr—June 30, 1906. No. 77858.

Refinery.

The Tacoma Copper Refinery. Day Allen Willey. Illustrated description of the plant and its operation. 500 w. Eng & Min Jour—July 28, 1906. No. 78280.

GOLD AND SILVER.

Australia.

Great Boulder Proprietary Gold Mine. Robert Allen. Illustrated description of the ore reduction plant and process of reduction. 2700 w. Min Jour—June 23, 1906. Serial. 1st part. No. 77786 A.

Kalgoorlie Revisited. Donald Clark. Remarks on the improvements in water supply, labor, methods of treatment, reduction in costs, etc. 3000 w. Aust Min Stand—June 6, 1906. No. 77874 B.

Power Generation and Costs at the Great Boulder Perseverance Mine, Western Australia. From the Monthly Journal of the Chamber of Mines of W. Australia. Detailed description of the power plant at this gold mine. 2000 w. Min Rept—June 28, 1906. No. 77739.

British Columbia.

Preliminary Report on the Rossland Mining District. R. W. Brock. A general review of investigations, giving the history, geology, topography, ore deposits, and mineral contents, methods of mining, processes of treatment, etc. copper, gold, silver and other minerals of value. Ills. Also editorial. 16800 w. B C Min Rec—June, 1906. No.. 78084 B.

Rossland Mining. Alfred W. Dyer. A report of progress and recent discoveries, and the copper-gold deposits. 1000 w. Can Min Rev—July, 1906. No. 78093 B.

The Eva Mine. Alfred W. Dyer. An illustrated account of a successful gold mine, developed under unfavorable conditions. 1200 w. Can Min Rev—July, 1906. No. 78092 B.

California.

Gold Mining in Siskiyou County, California. C. Godfrey Gunther. An account of methods applied in old placer fields that have been worked over by the early prospectors. 2000 w. Mines & Min—July, 1906. No. 77907 C.

Chile.

Some Silver-Bearing Veins of Caracoles, Chile. Gives a description of these deposits so far as explored. 1000 w. Min Jour—June 30, 1906. No. 77890 A.

Concentration.

Notes on the Treatment of Hard-Gangued Concentrating Ores. George Huston. Notes resulting from carefully studied practice designed to assist in laying out a flow sheet suitable for hard-gangued ores. 900 w. Min Rept—June 28, 1906. No. 77738.

Cyanide.

Cyanide Practice at the Liberty Bell Mill, Telluride, Colorado. W. E. Tracy. Illustrates and describes the methods of extraction used for a decomposed quartz ore containing a large amount of clay and talc. 900 w. Engr & Min Jour—July 28, 1906. No. 78281.

Mechanical Aids to the Cyanide Process. Illustrates and describes the Garvin machines for agitation and cyanidation of ore pulps, together with electro-deposition of the values from the cyanide solution. 1300 w. Min Rept—July 5, 1906. No. 77849.

Dredging.

Gold Dredging in the Urals, with Notes on Dredging in Siberia. William H. Shockley. An illustrated article giving data of gold-dredging in the Urals, and information regarding the country, labor, etc. 2000 w. Bul Am Inst of Min Engrs—July, 1906. No. 78253.

Galena.

The Daly-West Mine, Park City, Utah. An illustrated description of this silver-lead mine and the methods of working. 2200 w. Eng & Min Jour—July 7, 1906. No. 778-3.

Gold.

The Gold in the World and its Extraction (L'Or dans le Monde et son Extraction). L. de Launay. A review of the statistics of recent gold production in various parts of the world, with some account of the geology, and of the methods of extraction leading to the present greatly increased production. Two articles. 12000 w. Rev Gen d Sciences—June 15. 30, 1906. No. 78184 each D.

Low-Grade Ore.

New Sources of Gold. Waldon Fawcett. An illustrated description of the concentrating machines under trial by the U. S. Government for handling low-grade gold deposits, and for the investigation of the "black sand." 1500 w. Sci Am—July 21, 1906. No. 78063.

Nevada.

The Stamp Mill and Cyanide Plant of the Combination Mines Company at Goldfield, Nevada. Mark R. Lamb. Illustrated detailed description of the equipment and working of a mill for the extraction of gold and silver. 1600 w. Eng & Min Jour—June 30, 1906. No. 77744.

Ontario.

The Cobalt Mining District. W. M. Courtis. Information of interest concerning this district, the richness of the ore, masses of native silver, cobalt, nickel, bismuth, arsenic and a little gold are found. Ills. 1300 w. Eng & Min Jour—July 7, 1906. No. 77842.

Ore Reduction.

The Francke-Tina Process for the Reduction of Silver Ores, as Carried on at Caylloma, Peru. Alfred Fox. Gives a description of the working of this process, which is said to be very expensive. Ills. 2800 w. Inst of Civ Engrs—No. 3571. No. 78024 N.

Placers.

Development of Placer Gold Mining in the Klondike District, Canada. J. B. Tyrrel. Abstract of a paper read before the Inst. of Min Engrs. Calls attention to the difficulties encountered, the plans successfully adopted to overcome them, and the constantly reduced cost of mining. The method of steam-thawing is described. 2000 w. Ir & Coal Trds Rev—June 22, 1906. No.77789 A.

Prospecting.

Prospecting a Gold Placer. A description of the machinery used and methods of operating and of calculating values from the results. Ill 3000 w. Mines & Min—July, 1906. No. 77911 C.

Pyrite.

The Relations Between Gold and Pyrite. Henry Lloyd Smyth. Gives a brief account of an occurrence of gold, showing an important distinction to the miner, between the two varieties of pyrite. 1000 w. Min & Sci Pr—July 14, 1906. No. 78200.

Tonopah.

Tonopah, Nevada. Claude T. Rice. An illustrated account of present conditions at this important silver mine, with brief description of the geology of the region. 2200 w. Eng & Min Jour—July 21, 1906. Serial. 1st part. No. 78082.

IRON AND STEEL.

Blast Furnaces.

A Simple Rotary Distributor for Blast Furnace Charges. David Baker. Illustrates and describes a design which may be applied to any form of double-bell charger, retaining the perfect gas-seal. 1000 w. Bul Am Inst of Min Engrs—July, 1906. No. 78249.

The Blast-Furnace Plant of the Federal Furnace Company. Plans and description of the blast furnace plant and ore storage yard of this company at South Chicago, Ill. 2500 w. Ir Age—July 19, 1906. No. 78012.

The Gas-Producer as an Auxiliary in Iron Blast-Furnace Practice. R. H. Lee. Presents the advantages of a gas-producer driven by forced blast as a means of supplying additional blast when needed. 1600 w. Bul Am Inst of Min Engrs—July, 1906. No. 78251 D.

The Heat Balance Sheet of the Blast Furnace. J. W. Richards. A treatment of this subject based on the researches of Sir Lothian Bell, illustrating by problems. 5000 w. Elec-Chem & Met Ind—Jul,y, 1906. No. 77914 C.

The Northern Iron Company's Blast Furnace. J. H. Granbery. An illustrated description of this furnace plant at Port Henry, N. Y., with a review of its interesting features. 2000 w. Eng & Min Jour—July 21, 1906. No. 78081.

Cast Iron.

See Mechanical Engineering, Materials.

Dry-Air Blast.

The Dry Blast Question (Zur Frage der Windtrocknung). B. Osann. A review of the later results obtained by the use of the Gayley dry-air blast, with comments. Serial. Part I. 3000 w. Stahl u Eisen—July 1, 1906. No. 78147 D.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Extensions.

Additions to the Illinois Steel Co.'s Plant. Plans and description of a new universal plate mill, and a rail mill, both to be electrically driven. 1500 w. Ir Trd Rev—July 5, 1906. No. 77806.

Gas Power.

Gas Blowing Engine Plant of the Indiana Steel Co. Illustrated description of machinery similar to that which is to supply the large plant at Gary, Indiana. 2800 w. Ir Trd Rev—July 26, 1906. No. 78260.

India.

Iron and Steel Manufacture in India. An account of conditions relating to iron and steel manufacture in India, and of a proposed plant for an organization to be known as the Tata Iron & Steel Co., Ltd. Ills. 3000 w. Ir Age—July 12, 1906. No. 77903.

Overstrain.

Effect of Low Temperature on the Recovery of Steel from Overstrain. E. J. McCaustland. Supplementary diagrammatic charts, showing the results of the heat-treatment of Specimens Nos. 1 to 12 to accompany a paper published in the May Bulletin, 1906. Bul Am Inst of Min Engrs—July, 1906. No. 78254.

Pig Iron.

See Mechanical Engineering, Materials.

Rolling.

Improvements in Rolling Iron and Steel. James E. York. Read at joint meeting of the Ir. & St. Inst. and Am. Inst. of Min. Engrs., London. Explains the difficulties which led to the designing of the York universal mill, describing the mill and discussing its advantages. 4000 w. Ir Age—July 26, 1906. No. 78227.

Rolling Mill.

The Jones & Laughlin Steel Company's New Structural Mill. Illustrated detailed description of a new mill recently completed at Pittsburgh. 2000 w. Ir Age—July 5, 1906. No. 77770.

Segregation.

Segregation in Steel Ingots. Charles L. Huston. Read at meeting of the Am. Soc. of Test. Mat. · Presents the results of tensile tests and carbon analyses from plates, showing how the steel varies throughout the different parts of the ingots. Ills. 2500 w. Ir Age—July 5, 1906. No. 77769.

Variations in Strength of Rolled Steel Plates Due to Segregation of Carbon. A review of a recent paper by Charles L. Huston on "Experiments on the Segregation of Steel Ingots in Its Relation to Plate Specifications." Ills. 2500 w. Eng News—July 26, 1906. No. 78232.

MINING.

Caving System.

The Caving System of Mining. W. H. Storms. Discusses the mining of low-grade ores, explaining the caving system, and its successful operation, describing its application at the Pewabic mine at Iron Mountain, Mich. 2000 w. Min & Sci Pr—July 14, 1906. No. 78097.

Electric Power.

Electricity in Mining (L'Electricité dans les Mines). Maurice Orban. A very complete description of the generating station and electrical equipment of the Hasard mines near Fleron, Belgium. Two articles. 7000 w. Soc Belge d'Electriciens—May, June, 1906. No. 78189, each F

Mining and Milling by Electric Power Machinery. Charles V. Allen. The first installment, with numerous illustrations of the application of electric power to mining operations. 3500 w. Engineering Magazine—August, 1906 .No. 78193 B.

Notes on the Introduction of Electric Power into Large Coal Mining Plants (Einige Gesichtspunkle für die Errichchtung Elektrischer Antagen auf Grosseren Steinkohlenberguierken). General suggestions as to prime movers, choice of current, switchboard arrangement, and working details; by the Dortmund Boiler Inspection Association. 4000 w. Glückauf—June 30, 1906. No. 78154 D.

Fire.

Fire Fighting with Continuous Ventilation in Gaseous Mines (Grubenbrandgewältigung bei Unzulässiger Ventilation in Gasreichen Kohlengruben). Johann Mayer. The miners are provided with suits and helmets supplied with air through hose connected to a central supply . 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen —July 7, 1906. No. 78152 D.

Filling.

Conveying Filling Material by Water (Le Remblayage par l'Eau). H. Schmerber. Describing the use of flowing water in pipes as a means of conveying rock or other filling material into disused workings. Examples from various mines are given. Two articles. 5000 w. Génie Civil—May 26, June 2, 1906. No. 78118, each D.

Haulage.

A Rateau Exhaust Steam-Driven Three-Phase Haulage Plant. William Maurice. Abstract of paper read before the Inst. of Min. Engrs. Introductory remarks with a description of a Rateau installation to supply power for underground haulage. 2000 w. Ir & Coal Trds Rev—June 22, 1906. No. 77788 A.

Head-Frame.

The Leonard Head-Frame. A. H. Halloran. Illustration, with brief description of the new head-frame recently erected at the Leonard shaft of the Boston & Montana Copper Mining Co., which embodies the most modern ideas in steel construction. 500 w. Min & Sci Pr—June 30, 1906. No. 77856.

Korea.

Mining in Korea. J. H. Curle. An illustrated account of mining conditions, labor, etc., principally relating to gold mining. 1700 w. Min & Sci Pr—July 21, 1906. No. 78284.

Milling.

Milling Practice at the North Star Mine, Nevada County, California. G. E. Alexander. An illustrated description of the unusual features of the mill, and of the electric precipitation, and other applications of electric power. 1400 w. Min Rept—July 19, 1906. No. 78090.

Ore Milling in Wisconsin. Illustrates and describes the milling practice used in the zinc-lead district. The wet concentrating, and the magnetic separation processes are described. 1800 w. Eng & Min Jour—July 28, 1906. No. 78282.

Mine Power.

The Distribution of Power on Mines. Contribution to the discussion of the paper by C. E. Hutton. A. E. Payne describes a system of apportionment of charges under power account at the mine of the new Primrose G. M. Co, Ltd. 1000 w. Jour S African Assn of Engrs—May, 1906. No. 77775 F.

Mine Surveying.

The Qualifications of a Mine Surveyor. Henry Briggs. Discusses the methods in England as compared with the United States and Germany, urging an improvement, and outlining the methods now being taught. 1600 w. Col Guard—July 6, 1906. No. 77977 A.

Mine Ventilation.

Electrically-Operated Ventilating Plant in Northberg Pit, Germany. Alfred Gradenwitz. Illustrates and describes an arrangement to utilize the advantages of alternating currents in the transmission of energy. 1700 w. Eng & Min Jour—July 14, 1906. No. 77943.

Mining Locomotives.

Electric Mining Locomotives in Great Britain. J. F. Gairns. Illustrated description of types employed in British practice. 800 w. Eng & Min Jour—July 7, 1906. No. 77844.

Mining Methods.

Methods of Mining, Hauling, and Screening at the Mines of the Aldrich Mining Company, at Brilliant, Alabama. T. H. Aldrich, Jr. States the conditions of the problem to be met and the solution. 6000 w. Bul Am Inst of Min Engrs—July, 1906. No. 78252 C.

Operation.

Some General Principles Governing the Operation of Mines. J. R. Finlay. General remarks with a division of mines into three classes, giving a scheme of cost-keeping, and stating the general principles claimed. 1600 w. Min & Sci Pr—July 21, 1906. No. 78285.

Peru.

The Mineral Resources of Peru. A. L. M. Gottschalk. Information concerning the variety of minerals of commercial value to be found. Alabaster, marble, cobalt, lead, mica, molybdenite, nickel, petroleum, salt, silver, gold, coal, etc. 3000 w. Min Wld—July 28, 1906. No. 78288.

Pumping.

Mine Pumping by Compressed Air. A. M. Patterson, Jr. Abstract of a paper read at Pittsburg meeting of the Coal Mining Inst. of America. Brief discussion of the four approved methods of pumping with compressed air as applied to mine use. 2200 w. Min Wld—June 30, 1906. No. 77717.

Rescue Apparatus.

A New Apparatus for Rescue Work in Mines. W. E. Garforth. Abstract of paper read before the Inst. of Min. Engrs. Discusses the requirements of rescue apparatus, and the efforts made to furnish such apparatus, the defects, etc., describing an apparatus designed by the writer. 2500 w. Ir & Coal Trds Rev—June 22, 1906. No. 77787 A.

The "Pneumatogen Rescue Apparatus for Mines. Richard Cramer. Illustrated description of this apparatus. The most essential part is a filter in which potassium-sodium peroxide constitutes the filtering material. 1400 w. Ir & Coal Trds Rev—July 6, 1906. No. 77992 A.

The Shamrock Rescue Apparatus at the Courrières Collieries. G. A. Meyer. Read before the Inst. of Min. Engrs. Reviews the development of portable apparatus for the breathing of oxygen, especially considering the latest results. Also editorial. Ills. Min Jour—June 23, 1906. Serial. 1st part. No. 77785 A.

Roasting.

A Novel Furnace for Roasting Fine Ore. Dr. Alfred Gradenwitz. Illustrated description of a furnace designed by G. O. Peterson, of Finland, and of its operation. 700 w. Ir Trd Rev—July 19, 1906. No. 78050.

Safety Appliances.

Safety Appliances for Electrical Apparatus in Coal Mines. Editorial on the researches carried out in the Westphalian district of Germany showing that electric machinery can be rendered safe in fiery mines without undue complications and at reasonable cost. 3000 w. Engng—July 20, 1906. No. 78312 A.

Shafts.

Concrete Lining for Mine Shafts. Carl Henrich. Describes the writer's views of the easiest and best way of putting in the concrete, and gives a comparison of costs of concrete lining and timbering. 1700 w. Min Wld—July 28, 1906. No. 78286.

How Bodies Fall in Deep Vertical Shafts. F. W. McNair. An explanation of some of the causes that deviate a falling object from the vertical, and reporting an investigation made at No. 5 shaft in the Tamarack mine. 2000 w. Min & Sci Pr—July 14, 1906. No. 78099.

The Deepening of the Julins Shaft at the La Houve Mine in Lorraine (Das Abteufen des Schachtes Julius der Bergwerks-Aktiengesellschaft La Houve bei Kreuzwald in Lothringen). H. Wewetzer. Describing the application of the Kind-Chaudron method for sinking a shaft through sand, clay, and water-bearing strata. 2000 w. Gluckauf—June 23, 1906. No. 78153 D.

Sieves.

Sieve and Screen Aperatures. George T. Holloway. Abstract from Bul. No. 5 of the Inst. of Min & Met. Gives tables showing the size of aperature obtainable with sieves of different mesh with wire of different gauge, and discusses the advisability of deciding upon some general standard. 1500 w. Min Wld—July 21, 1906. No. 78088.

Sketching.

Mining Sketching. Prof. Arthur Lakes. Illustrates and describes methods of drawing various kinds of timbering and showing the appearance of different openings and passages underground. 1800 w. Mines & Min—July, 1906. No. 77910 C.

Smelting.

The Imbert Process. E. Gibbon Spilsbury. Describes a process for the extraction of certain metals from their sulphides. 1800 w. Min & Sci Pr—June 30, 1906. No. 77857.

Tonopah.

The Tonopah Volcanoes. Prof. Arthur Lakes. Discusses the causes to which are due the appearance of the country and also the ore deposits. 700 w. Mines & Min—July, 1906. No. 77908 C.

Turkey.

Coal, Iron Ore, and Manganese in Asiatic Turkey. Bruno Simmersbach in *Zeitschrift fur Berg-Hutten-und Salinenwesen.* Information concerning the deposits and the development of this region. 2000 w. Ir & Coal Trds Rev—July 6, 1906. No. 77991 A.

Winding.

Duplex Tandem Winding-Engine. Illustrated description of a large horizontal duplex tandem winding engine made at Erith, stating the conditions it was constructed to fulfil. 2200 w. Engng—July 20, 1906. No. 78310 A.

Mine Winding-Engines. Illustrates and describes the important features of three different types of winding engines showing present practice. 2000 w. Engng—June 22, 1906. No. 77793 A.

The Westinghouse Converter Equalizer System for Variable Loads (Winding motors, rolling mills, etc.). Briefly describes and illustrates this system. 2000 w. Ir & Coal Trds Rev—June 22, 1906. No. 77792 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

The Salisbury Railway Accident. An illustrated account of the accident to the boat-train express on the South-Western Railway, England. 2000 w. Engng—July 6, 1906. No. 77984 A.

Clearing House.

The Railway Clearing House. A brief account of this institution and its functions. 3500 w. Engr, Lond—July 6, 1906. No. 77987 A.

Cost.

Cost per Mile Run. J. E. Goodman. Extract from address to the Northern Ry. Club, on the subject of locomotive repairs. 600 w. Ry & Loc Engng—July, 1906. No. 77864 C.

Difficult Feat.

A Difficult Railroad Transportation Feat. Illustrations, with brief account of the transportation of the very large castings of the "Lusitania." 400 w. Sci Am Sup—July 7, 1906. No. 77827.

Train Control.

The Raymond Phillips System of Train-Control. Brief illustrated description of this automatic train-control system. 1000 w. Engng—July 13, 1906. No. 78219 A.

MOTIVE POWER AND EQUIPMENT.

Cars.

New Third-Class Cars for the Midi Railway of France (Les Nouvelles Voitures de Troisième Classe de la Compagnie des Chemins de Fer du Midi). Francis Marre. Illustrating a new corridor carriage, for 66 third-class passengers. The design includes improved heating, lighting, and toilet arrangements. 1000 w. 1 plate. Génie Civil—May 19, 1906. No. 78116 D.

Electric Locomotives.

Electric Locomotive Tests on the Seebach-Wettingen Railway. Frank C. Perkins. Brief account of the tests, with illustrations. 1100 w. Ry & Engng Rev—July 14, 1906. No. 77958.

Electrification.

Electric Traction on the Lancashire and Yorkshire Railway. An illustrated account of new lines to be electrified, or already in service. Maps. 3000 w. Elec Engr, Lond—July 6, 1906. No. 77960 A.

Hammersmith and City Railway Electrification. Principally an illustrated description of the Park Royal power-station of the Great Western Railway. 6800 w. Tram & Ry Wld—July 12, 1906. No. 78212 B.

The Electrical Equipment of the Great Western Railway. An illustrated detailed description of the plan of generating stations and distribution. 6000 w. Elect'n, Lond—June 22, 29, 1906. Serial—2 parts. No. 77887 each A.

Front Ends.

Locomotive Front Ends. The report submitted by the committee appointed by the Master Mechanics Assn. 3000 w. Ry & Loc Engng—July, 1906. No. 77865 C.

Indicators.

Locomotive Tachographs. Illustrates and describes types of speed indicators for automatically registering the speed of trains, discussing their advantages. 1800 w. Engr, Lond—July 13, 1906. No. 78221 A.

Locomotive Frames.

Welding Locomotive Frames. Extracts from a paper by R. P. C. Sanderson, before the M. M. Assn. Report of the writer's experiences in learning to use Thermit successfully. 2200 w. R R Gaz—July 13, 1906. No. 77950.

Locomotives.

American Experience with Compound Locomotives. Remarks on the railways using large numbers of compounds and their service. 1700 w. Engr, Lond—July 20, 1906. No. 78314 A.

An Interesting Locomotive Conversion. Illustrations showing the changes made in reconstructing a three-cylinder compound (Webb's system) 0-8-0 type mineral locomotive to a simple engine. 1400 w. Mech Engr—June 23, 1906. No. 77782 A.

Baldwin Locomotives for the Union Pacific and Great Northern Railways. Illustrated descriptions of two locomotives exhibited at Atlantic City during the recent convention of the Am. Ry. Mas. Mech's Assn. 1100 w. Ry Age—July 20, 1906. No. 78095.

Baltimore & Ohio Railroad Motive Power. Illustrates and describes the latest addition to the locomotive equipment, consisting of some very heavy and powerful Pacific type engines. 1500 w. Am Engr & R R Jour—July, 1906. No. 77760 C.

Lake Champlain & Moriah 2-8-2. Illustrated description of an engine designed to work on 4° grades and to pass around 14 deg. curves. 800 w. Ry & Loc Engng—July, 1906. No. 77863 C.

Locomotive for the Hungarian State Railways. Illustrated description of a four-cylinder compound, four-coupled wheel, 4-4-2 type engine shown at the Milan Exhibition. 1300 w. Engng—July 20, 1906. No. 78309 A.

Locomotive Improvements: L. & N. W. Railway. Charles S. Lake. Considers alterations made in types of locomotives, raising the boiler power, adding extra wheels, etc. 1000 w. Mech Engr—July 21, 1906. No. 78303 A.

Mogul Locomotives for the Panama Excavation. Illustrates and describes two designs to be used in the construction of the Panama Canal. 120 have recently been completed. 800 w. R R Gaz—July 20, 1906. No. 78056.

Mountain Climber in Upper Burma. Brief illustrated description of en engine used on the Darjiling-Himalayan railway, a narrow gauge road 24 ins. wide. 400 w. Ry & Loc Engng—July, 1906. No. 77866 C.

New Locomotives for Mixed Driving on the Brünig Railway (Neue Lokomotiven der Brünigbahn für Gemischten Betrieb). Illustrating four-cylinder compound engines for adhesion and rack-railway service on the railway over the Brünig pass, in Switzerland. 1200 w. Schweiz Bauzeitung—June 16, 1906. No. 78140 B.

Pittsburg and Lake Erie Switching Locomotive. Illustrated description of a type of engine for use in the gravity yards to push heavy trains up the "hump." 700 w. Ry Age—July 27, 1906. No. 78292.

Rack Locomotive for Manitou and Pike's Peak Railway. Illustrated description of some new engines for this road, which is operated on the Abt rack-rail system, with a maximum grade of 25 per cent. 700 w. R R Gaz—July 13, 1906. No. 77949.

Recent de Glehn System Compound Locomotives. Illustrations and particulars of recent types of engines, compounded on the de Glehn system, and supplied to French and German railways. 1600 w. Mech Engr—July 14, 1906. No. 78207 A.

Simple Consolidation Locomotive with Walschaert Valve Gear. Illustrated description of a new design for the L. S. & M. S. R. R. 700 w. Am Engr & R R Jour—July, 1906. No. 77761 C.

Six-Coupled Passenger Express Locomotive; Caledonian Railway. Illustrated description of engines especially built for the Grampian express service. 800 w. Engng—June 22, 1906. No. 77796 A.

Motor Car.

Steam Motor Car for the Canadian Pacific. Illustrated description of an oil-burning steam motor car in service on this line. 600 w. R R Gaz—July 20, 1906. No. 78055.

Train Lighting.

The Electric Lighting of Railway Trains on the L'Hoest-Piper System. G. L'Hoest. Describes this system in which a single generating set is employed which provides the electric energy required for the whole train, the current being distributed to the vehicles in series. Ills. 4800 w. Bul Int Ry Cong—June, 1906. No. 78035 E.

Train Resistance.

The Tractive Resistance of Railway Trains (Ueber die Zugwiderstande der Eisenbahnfahrzeuge). P. Denninghoff. An examination of the various formulas for train resistance, with curves showing the resistances due to wind, friction, and load; with suggestions as to improved forms of cars. 5000 w. Glasers Annalen—June 15, 1906. No. 78142 D.

NEW PROJECTS.

Canada.

Canadian Railroad Expansion. S. J. M'Lean. Concerning projected lines and the development of the railroad systems of Canada, and the interests which they serve. 4000 w. R R Gaz—July 6, 1906. No. 77814.

China.

The Pekin-Hankow Railway in China. P. H. Ashmead. Map and illustrated description of the line and its equipment, with information of interest. 3000 w. Eng News—July 12, 1906. No. 77923.

Extensions.

Lancashire and Yorkshire Railway. An illustrated detailed description of the new equipment and extensions of the Liverpool and Southport electric line. 4000 w. Tram & Ry Wld—July 12, 1906. No. 78211 B.

New Line.

The Opening of the Great Western's New Main Line. Charles Rous-Marten. Information concerning the opening of a line connecting London with Exeter, Plymouth, and the far west, with particulars of its rolling-stock, operation, etc. 3300 w. Engr, Lond—July 6, 1906. No. 77989 A.

Tehuantepec.

The Tehuantepec Railway and the Harbors at Its Ocean Terminals. An illustrated detailed description, with information of interest. 2000 w. Eng News—July 5, 1906. No. 77816.

PERMANENT WAY AND BUILDINGS.

Amsterdam.

Plan for the Improvement of the Railway Connections at Amsterdam (Ontwerp-Verbetering der Spoorwegverbindingen om Amsterdam). N. W. Nierstrasz. A long report to the Institute of Engineers with plans for a new terminal, a ring railway, and extended facilities. 10000 w. 2 plates. De Ingenieur—April 14, 1906. No. 78181 D.

Culvert.

A Low-Cost Concrete Culvert. W. H. Whorley. Read before the Engng. Assn. of the South. Describes a 12-ft. full-centered concrete arch culvert with 6-ft. side walls constructed on the Nashville, Chattanooga and St. Louis Ry. Gives tables of cost of concrete structures. 1200 w. Eng News—July 5, 1906. No. 77818.

Interlocking.

Power Interlocking Plants in Great Britain and on the Continent. Considers the methods of operating railway switches and signals by power. 2000 w. Ry Age—June 29, 1906. No. 77734.

Mountain Roads.

The Design of Rack Railways (Les Chemins de Fer à Crémaillère). A. Levy-Lambert. A very complete review of the various types of rack railways and locomotives, as used on steep grades in mountainous districts in Europe and America. 15000 w. Mem Soc Ing Civ de France—March, 1906. No. 78139 G.

Power Plant.

Power Plant in the Silvis Shops of the Rock Island System. O. Monnett. Illustrated detailed description of a power house distributing electric power, compressed air, hydraulic power, live steam, exhaust steam, service water, hot water and drinking water. 3000 w. Engr, U S A—July 2, 1906. No. 77746 C.

Rails.

Rail Corrugation. F. T. Aman. A report of an investigation of such rails by means of the microscope and camera. Ills. 1000 w. Tram & Ry Wld—July 12, 1906. No. 78213 B.

Reconstruction.

Big Four Reconstruction, Indianapolis to Coal Bluff. Illustrates and describes some of the heaviest work undertaken in carrying forward betterments of this road. 59 miles of double track replace existing single track, and 20 miles of cut-off. 2000 w. Ry Age—July 6, 1906. No. 77853.

Rebuilding the Highland Division of the New York, New Haven & Hartford. An explanation of the new lines recently acquired by the N. Y., N. H. & H. R. R. and the work undertaken to prepare the lines for modern traffic, especially the double-tracking of the line from Hopewell, N. Y., to Danbury, Conn. Ills. 2500 w. R R Gaz—July 13, 1906. No. 77947.

Signaling.

Combined Manual and Automatic Block Signaling on the C., N. O. & T. P. An explanation of the operations of the system near Danville, Ky., where a single track is signaled by the controlled manual system for opposing trains and by track circuit signals for following trains. 1000 w. R R Gaz—July 27, 1906. No. 78265.

Electric Signaling on English Railroads. A report of the progress of the electrification of signals in England, and the cause of the delay. Ills. 1600 w. Elec Engr, Lond—June 29, 1906. Serial. 1st part. No. 77885 A.

The Use of Electric Currents with Isolated Rails for the Control of Trains (Over Stroomketens met Geisoleerde Rails ter Beveiliging van den Loop der Treinen). J. D. C. M. de Roos. A study of electric signalling for single and double track railways. 12000 w. Tijdschr van het Kljk Inst van Ingenieurs—Feb. 3, 1906. No. 78187 H.

Station.

New Passenger Station for the B. & O. R. R. at Wheeling, W. Va. An illustrated description of a fireproof structure having three stories and attic, but no basement, as the location is such that it would be flooded during high water. 1000 w. Ry & Engng Rev—July 7, 1906. No. 77855.

The Enlargement of Victoria Station. Begins an illustrated detailed description of this reconstructed and greatly enlarged station on the London, Brighton, and South Coast Railway. 5000 w. Engng—July 13, 1906. Serial. 1st part. No. 78215 A.

Steep Grades.

The Lake Champlain & Moriah Railroad. J. H. Granbery. Map and description of this line with illustrated account of an unusual accident causing the wreck of a locomotive and seven ore cars. 1400 w. Eng & Min Jour—June 30, 1906. No. 77742.

Ties.

The Carnegie Steel Tie. An illustrated article explaining results obtained by the use of steel ties and giving information relating to them. 1000 w. R R Gaz—July 20, 1906. No. 78058.

Warehouse.

A Large Railway Freight House and Warehouse at Pittsburg, Pa. A warehouse and freight station which provides numerous private rooms for independent firms, is illustrated and described in detail. 3500 w. Eng News—July 19, 1906. No. 78067.

TRAFFIC.

Car Service.

Division of Foreign Cars—Remedies Suggested. J. W. Midgley. Considers instances of unfair division, the causes, and remedies. 3000 w. Ry Age—July 27, 1906. No. 78291.

Weak Points in the Car Service Rules and the per Diem Code. J. W. Midgley. A discussion of certain points showing the conditions and need of remedy. 3800 w. Ry Age—July 20, 1906. No. 78096.

MISCELLANY.

Address.

Address of President Ball to the Master Mechanics Association. Discusses progress and improvements of the last ten years, the motive power problem, and other topics of interest. 4500 w. Am Engr & R R Jour—July, 1906. No. 77759 C.

Mortgages.

Types of Railroad Mortgages. Thomas W. Mitchell, in the *Journal of Accountancy*. An explanation of the various types of mortgages and the purposes they serve. 3500 w. R R Gaz—July 6, 1906. No. 77812.

Organization.

Organization of the Pennsylvania Railroad, 1906. An abstract made from comments in a paper by A. J. County, on the division of responsibility throughout the system. 4000 w. R R Gaz—July 13, 1906. No. 77948.

Siberia.

A Lost Railroad. L. Lodian. Relates an interesting historic incident in the construction of the Trans-Siberian railway. 2500 w. Elec Rev, N Y—June 30, 1906. No. 77737.

Supplies.

Testing and Inspection of Railroad Supplies. Robert Job. Gives an outline of some of the important test work carried out regularly on the Philadelphia & Reading Railway. 2000 w. Jr Fr Inst—July, 1906. No. 78009 D.

STREET AND ELECTRIC RAILWAYS

Brakes.

Brake-Rigging and Uneven Wear of Brake-Shoes. W. L. Boyer. Calls attention to faults in design and the conditions responsible for many of the troubles. Ills. 4000 w. St Ry Jour—July 21, 1906. No. 78073 C.

Chicago.

The Status of the Chicago Traction Problem. Louis Albert Lamb. Discusses the "99-years" claims of the Chicago street railways, and the result of the decision of the United States supreme court. 3300 w. Elec Ry Rev—July, 1906. No. 77966.

Elevated Railway.

A Proposed Elevated Railway of 1827. Illustrates an elevated double track railway shown in an old pamphlet issued in 1827 by John Langdon Sullivan, giving the advantages claimed. 1000 w. Eng News—July 19, 1906. No. 78069.

Improvements.

Improvements and Operating Features of the Southwest Missouri Electric Railway. Describes the extensions and track work, the new line, new cars, etc., and the system of operation. 4000 w. St Ry Jour—July 21, 1906. No. 78072 C.

Improvements on the St. Louis and Suburban Railway. An illustrated article describing reconstruction and double tracking, the erection of a new substation, etc. 1500 w. St Ry Jour—June 30, 1906. No. 77728 C.

Incline.

A Cable Incline Railway with Endless Cable. The Bernardit system adopted at Nancy, France, is illustrated and described. 1000 w. Eng News—July 12, 1906. No. 77926

Milwaukee.

Commerce Street Power Plant of the Milwaukee Electric Railway and Light Company. Illustrated description of the plant which supplies practically all the current required to operate the extensive street and interurban railway system. 5500 w. St Ry Jour—July 28, 1906. No. 78278 C.

The New Public Service Building of the Milwaukee Electric Railway and Light Company. Illustrated detailed description of a building which combines a terminal station for interurban service, and an office building devoted to the needs of the company. 6000 w. St Ry Jour—July 14, 1906. No. 77932 C.

Power.

Power Supply to Tramway Systems. S. J. Watson. Read before the Incor. Munic. Elec. Assn., London. The subject applies only to small or medium-sized districts operating from 6 to 30 cars. Discusses whether the supply can be best given by storage batteries and a reversible booster, or run directly on the traction load. 5000 w. Elect'n, Lond—July 6, 1906. No. 77973 A.

Power Plant.

The Commerce Street Power Plant of the Milwaukee Electric Railway & Light Company. Illustrated description of the changes which have more than doubled the capacity of the plant. 2800 w. Elec Ry Rev—July, 1906. No. 77965.

Rail Joints.

Rail Joints for Electric Street Railways (Die Stossverbindung der Rillenschienen Elektrischer Strassenbahnen). Max Buchwald. Illustrations of various forms of German rail joints, and of a portable milling machine for finishing the surfaces. 3000 w. Elektrotech Zeitschr—June 28, 1906. No. 78165 B.

Rapid Transit.

Rapid Transit in Chicago. A report submitted by Bion J. Arnold to the Committee on Local Transportation of the Chicago City Council, July 2, 1906. Recommendations as to what to do at present. Map. 2800 w. R R Gaz—July 13, 1906. No. 77951.

The 60,000-Volt Sub-Station and Transmission Line of the Syracuse Rapid Transit Company. An account of the transmitting of a 60,000-volt current generated at Niagara Falls, 165 miles to Syracuse, to be utilized for operating the traction system of the city. 4500 w. St Ry Jour—July 14, 1906. No. 77933 C.

Shops.

The New Car House and Remodeled Shops of the International Railway Company, Buffalo, N. Y. Illustrates and describes recent improvements in the carhouse and shop facilities at the Cold Springs depot. 4500 w. St Ry Jour—July 7, 1906. No. 77847 C.

Signalling.

Some Recent Block Signal Systems for Electric Railways. Gives particulars of some systems which have been put in service, with diagrams. 3500 w. Eng News—July 19, 1906. No. 78070.

Single Phase.

The Finzi Single-Phase Railway System (La Ferrovia Monofase Sistema Finzi). A brief description, with sheet of illustrations of the Finzi system of monophase electric traction, as exhibited at Milan. 1200 w. 1 plate. L'Industria—April 29, 1906. No. 78177 D.

Snow.

Methods of Handling Snow on Electric Railways. Gives particulars as to methods and equipments employed by a number of interurban railways in different parts of the United States. Ills. 4500 w. Eng News—July 26, 1906. No. 78234.

Station.

Commonwealth Electric Company's New Station. An illustrated detailed description of the first steam turbine generating station in Chicago. 4000 w. Ir Age—July 20, 1906. No. 78226.

Park Royal Power Station and the Hammersmith and City Electric Railway. Detailed description of the new generating station of the Great Western Ry. Co., and the lines which it serves. 3500 w. Elec Rev, Lond—June 22, 1906. Serial. 1st part. No. 77778 A.

Subways.

Station Locations in the Washington Street Tunnel, Boston. Map, plans, and description of the Washington Street tunnel and platforms. 1000 w. Ry Age—July 27, 1906. No. 78289.

Test Commission.

Electric Railway Test Commission. Henry V. Norris and Bernard V. Swanson. An analysis of the work by this commission, discussing its organization, the investigations and deductions. 2800 w. Elec Ry Rev—July, 1906. No. 77964.

Traction.

Electric Traction at 2400 Volts (Traction Electrique à 2400 Volts). An account of the St. Georges de Commières à la Mure line near Grenoble, France, taking its current from the hydro-electric station in the Alps; with details of the route and the locomotives. 2500 w. Génie Civil—June 2, 1906. No. 78119 D.

Turbine Plant.

New Turbine Plant for Railway Lighting and Power Service. Illustrated description of a new system, employing alternating-current transmission at high voltage, recently installed at Portsmouth, Ohio. 2000 w. Engr, U S A—July 16, 1906. No. 77993 C.

Underground.

The Paris Metropolitan Railway; the Place de l'Opéra. An illustrated account of the special difficulties encountered in the construction at this point. 1100 w. Engng—July 6, 1906. No. 77986 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin .
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. o fEngineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London .
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age . *w.* Chicago.
Railway & Engineering- Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Far. *m.* Paris.
Revue Gén .des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

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